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Big Thicket National Preserve
Water Corridors Management Assessment

Prepared by

Dr. Paul A. Harcombe, Principal Investigator
Professor, Department of Ecology and Evolultionary Biology
Rice University

Glenda Callaway, Co-Principal Investigator
Principal, Ekistics Corporation

Under Cooperative Agreement With
National Park Service
Big Thicket National Preserve
Richard "Pete" Peterson, Superintendent

28 February 1997

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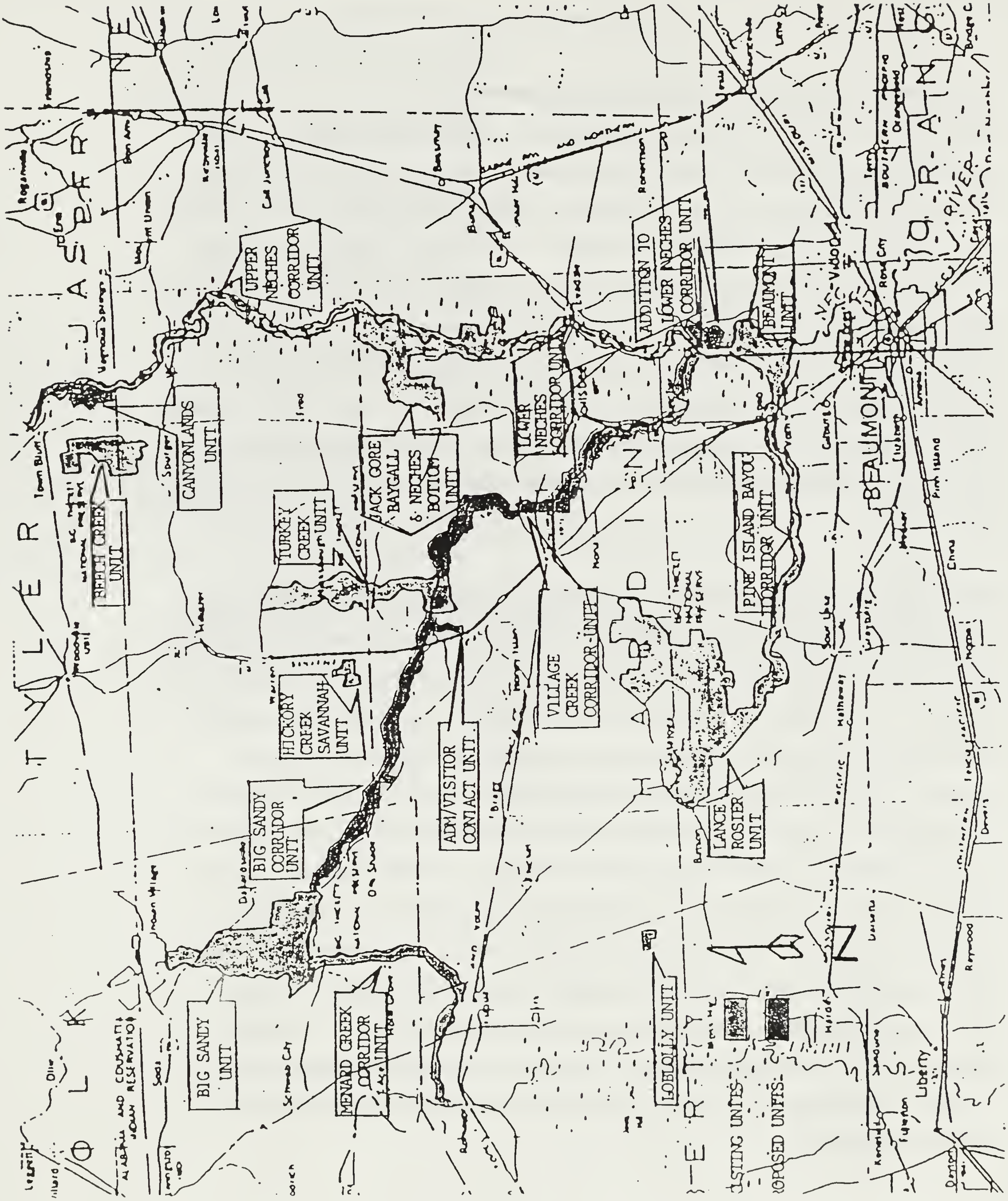
1.0 Introduction

1.1 Description of the Preserve and Mission Statement

Situated in the East Texas Pineywoods region, the Big Thicket National Preserve (BTNP or the Preserve) includes parts of Hardin, Jasper, Jefferson, Liberty, Orange, Polk and Tyler Counties. The Preserve is made up of fifteen units, including three added in 1993, and has a total authorized area of 96,970 acres. (See Figure 1, BTNP Location Map.) The widely dispersed land units and the water corridor units were intended "to assure the preservation of numerous representative areas typical of the Big Thicket region and protect and preserve the natural values which make this 'biological crossroads' unique in the United States" (H.R. 93-676, November 29, 1973). Congress has directed the National Park Service (NPS) to manage the units of the Preserve "in a manner which will assure their natural and ecological integrity in perpetuity" and to allow for public use and enjoyment (P.L. 93-439, October 11, 1974; 88 Stat. 1254).

The Preserve is located in an area whose economy has been dominated by the timber and oil and gas industries and agriculture. While the Preserve is close to the major population centers of the Golden Triangle (Beaumont, Port Arthur and Orange) and Houston, it contains some of the most remote "backwoods" remaining in the state. Most of the local population could be characterized as having the very independent rural attitude associated with American pioneers. Some of the local population maintains lifestyles reminiscent of the pioneer era. At the same time, the area is slowly being encroached upon by growth from the nearby urban centers. The tensions created by resistance to urbanization as well as tensions created by a federal presence in an area where many are accustomed to unfettered access to common property resources (whether they are in fact publically owned), coupled with the pressures of environmentalists to preserve the unique biological heritage embodied in the Preserve in the face of increasing public use and decreasing public funds make a lively mix of challenges faced by the NPS in managing the BTNP. The issues encountered in managing the water corridors of the Preserve are a good example of the types of considerations encountered throughout the BTNP.

FIGURE1. BTNP LOCATION MAP


UPPER NECHES CORRIDOR UNIT
CANYONLANDS UNIT
BEECH CREEK UNIT
TURKEY CREEK UNIT
JACK GORE BAYGALL & NECHES BOTTOM UNIT
LOWER NECHES CORRIDOR UNIT
ADDITION TO LOWER NECHES CORRIDOR UNIT
BEAUMONT UNIT
PINE ISLAND BAYOU CORRIDOR UNIT
VILLAGE CREEK CORRIDOR UNIT
ADM/VISITOR CONTACT UNIT
HICKORY CREEK SAVANNAH UNIT
BIG SANDY CORRIDOR UNIT
BIG SANDY UNIT
MENARD CREEK CORRIDOR UNIT
LANCE ROSIER UNIT
LOBLOLLY UNIT
ISTING UNITS
ROPOSED UNITS
N
TYLER
JASPER
HARDIN
POLK
LIBERTY
ORANGE
BEAUMONT
RIVER
Liberty
ALABAMA AND COUSHATTA INDIAN RESERVATION

1.2 Role/Function of the Water Corridors in the Preserve

Eight of the BTNP units, including the newly authorized Big Sandy Corridor Unit and the Village Creek Corridor Unit, are river, creek and bayou corridors. These eight units, which lie along four waterways, were studied for this management assessment:

Neches River - Upper Neches River Corridor Unit
  Neches Bottom and Jack Gore Baygall Unit
  Lower Neches River Corridor Unit
  Beaumont Unit
Little Pine Island-Pine Island Bayou Corridor Unit
Menard Creek Corridor Unit.
Village Creek - Big Sandy Corridor Unit
  Village Creek Corridor Unit

The corridor units along these low-gradient coastal plain streams are intended to preserve critical aquatic habitat and to serve as a linkage between surrounding floodplain forests, providing some continuity to the otherwise dispersed units of the Preserve. The value of a corridor unit as a preserve is determined by the degree to which that unit represents and will continue to represent a functioning community such as would originally have been present at that location prior to land use changes associated with European colonization (Harcombe et al 1996). The water corridor units may serve as wildlife corridors, although this function may be diminished by the narrow land area of most of the corridor units. The streams also are used by the public, primarily for boating and fishing.

1.3 Purpose of the Water Corridor Management Assessment

The purpose of the Water Corridor Management Assessment is to provide a baseline of information and action options for the NPS to accomplish the seven objectives it has established for the water corridors of the BTNP:

1. To manage water corridor use consistent with the purposes for which BTNP was established and in accordance with the missions and policies of the NPS.

2. To manage the waterways to preserve the natural setting and restore as much as possible of the presettlement scene, preventing further degradation to critical

resources, water quality, and ecological integrity of the water corridors.

3. To implement an economically efficient system of management that will provide fair and equitable opportunity for the public to enjoy the water resources of the Preserve.

4. To maintain and enhance diverse opportunities for experiencing nature, solitude, and recreational pursuits.

5. To enhance the visitor's opportunity to learn about, understand, and participate in the protection of the natural and historic setting of the water resources of the Preserve.

6. To promote the acceptance of safety, health and critical resource protection requirements by all water corridor users and by those outside the Preserve that potentially impact the corridors.

7. To implement a scientific monitoring program on key aspects of the riparian and aquatic ecosystem and human use of, and impacts to, the water corridor. This will allow management to establish and recognize threshold levels of adverse impacts and implement appropriate management actions.

The management assessment is organized around the concept of protecting the "critical resources" of the Preserve.

1.4 The Concept of Critical Resources

For purposes of the Water Corridor Management Assessment for Big Thicket National Preserve (BTNP or the Preserve), critical resources are defined as ***those resources that are essential to maintaining ecosystem integrity and that are particularly sensitive to adverse impact by external activities and decisions.*** Ecosystem integrity is defined here as the state of a system in which there exists the natural complement of species, their habitats, and characteristic processes, substantially unaffected by human activity.

Critical resources, then, have two elements: 1) they are important natural components of the BTNP ecosystem and 2) their continued existence may be threatened by human activity. These are the resources that are most critically in need of management. In many cases, the identification of critical resources also points to the form of needed management actions.

1.5 The Identification of Critical Resources of the Water Corridors

The first step in identifying critical resources of the water corridors of the Preserve was to characterize the biota and natural processes of the ecosystem, including: water quality and flow trends; fish and aquatic invertebrates; vegetation; and threatened and endangered species. These elements are described in more detail in "Characterization of the Biological Resources of the Water Corridor Units of the Big Thicket National Preserve" (Harcombe et al, 1996) and "Water Quality Characterization of the Water Corridors of the Big Thicket National Preserve" (Hall and Bruce, 1996). The natural characteristics of the Preserve and surrounding lands were summarized in a "Land Cover/Land Use Map" (Hall et al, 1994) as depicted in Figure 2. The next step was to identify and categorize potential threats to the natural elements by impacts associated with: 1) alteration of natural processes; 2) public use of the Preserve; or 3) interagency/inter-institutional relations. Two reports detailed these issues: "A Case Study of Flooding in the Neches Bottom Study Site" (Hall, 1994) and "Issues for Water Corridors of the Big Thicket National Preserve" (Callaway, 1994).

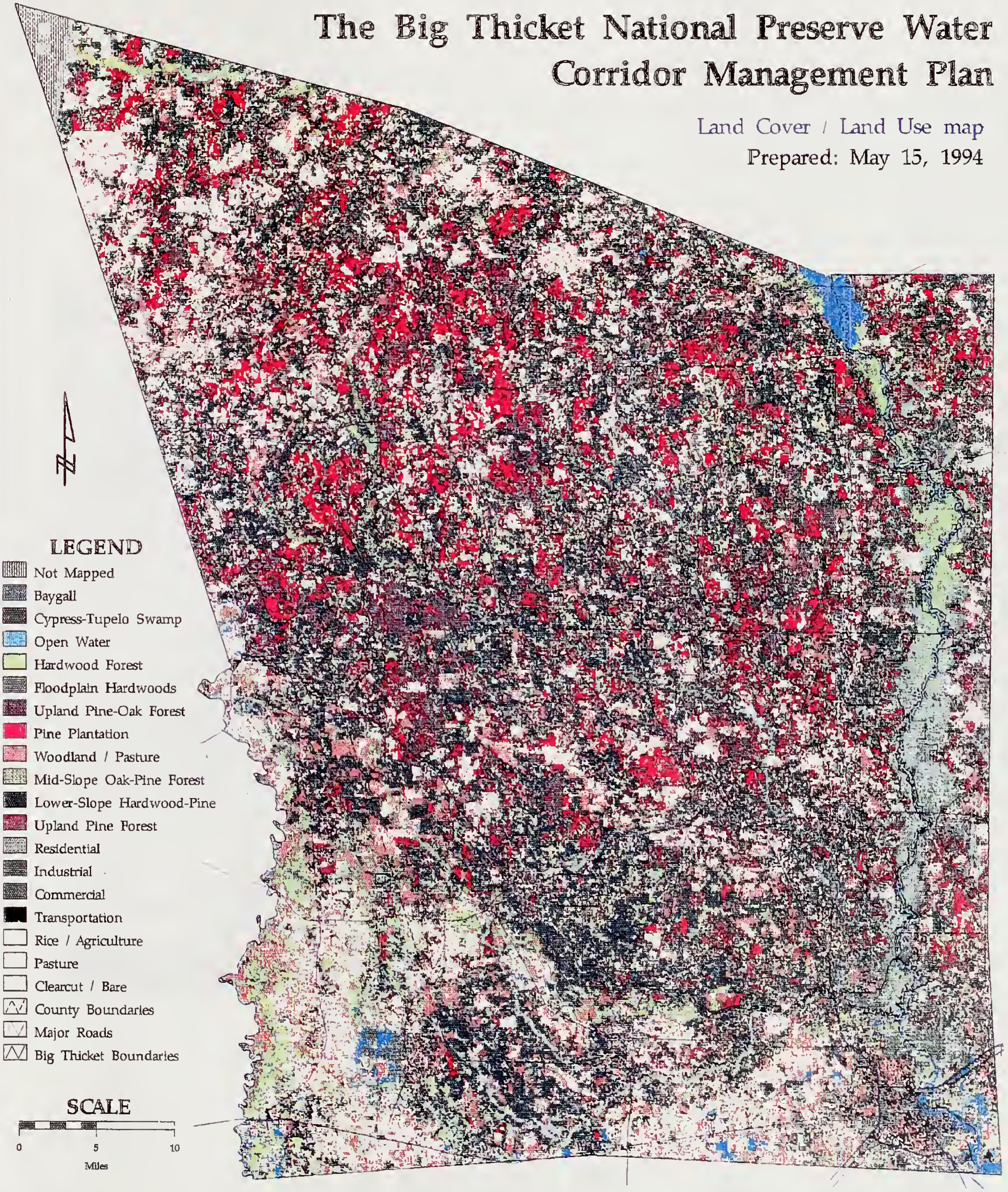
A matrix was then constructed to summarize the relationships between the Preserve's natural resources and those human activities that might impact them. Initially, two matrices were envisioned, one breaking down resource use activities into impacts, and a linked matrix showing the effects of these impacts on Preserve resources. This approach was later simplified and the two matrices were combined into a single Critical Resources Matrix (see Figure 3). The matrix indicates whether an issue affects a resource (>), or a resource influences a given issue (<), or whether influences operate in both directions (X). The single matrix format was selected as being less duplicative and more informative. This matrix is a way of linking activities to impacts on the resources of BTNP in terms of measurable characteristics of those resources. The matrix also suggests areas in which characterization information, particularly quantitative data, is needed, as, for example, when potential impacts are identified to species resources for which trend data are not yet available.

The Critical Resources Matrix presents management "issues" on the vertical axis and "resources", stated in a way that can be monitored, on the horizontal axis. The issues

The Big Thicket National Preserve Water Corridor Management Plan

Land Cover / Land Use map

Prepared: May 15, 1994



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Based on Landsat TM Image taken February 10, 1991

Figure 3 Critical Resource Matrix

	Minimized fragmentation	Interior habitat (area)	Bottomland hardwood forest, wetlands (area)	Upland forest (area)	Slope forest (area)	Flatland forest (area)	Snags-forest	Snags-submerged	Stream banks-vegetation (area)	Submerged aquatic habitat (area)	Air quality-volume of emissions	Air quality-toxics ppm (aerial deposition?)	Water quality-excess nutrients	Water quality-total organic carbon	Water quality-dissolved organic carbon	Water quality-temperature	Water quality-salinity	Water quality-fecal coliform	Water quality-sediment	Water quality-heavy metals	Water quality-toxins	Water quality-dissolved solids	Water quality-suspended solids	Water quality-pH	Water quality-dissolved oxygen	Water flow-amount	Water flow-seasonality	Birds-species and individuals*	Mammals-species and individuals*	Reptiles and amphibians-species and individuals*	Fish-species and individuals*	Invertebrates-species and individuals*	Vegetation-species and individuals*	Exotic species-species and individuals*	Stream banks-erosion (presence or absence?)	Scenic/aesthetic qualities
Biotic Issues																																				
Declining biodiversity	<	<	<				<	<		<						<	<	<	<	<		<	<	<	<	<	<	x	x	x	x	x	x	<		>
Threatened and endangered species																												x	x	x	x					
Introduction of exotic species			>						>	>															>							>	>	x	>	>
Hydrology Issues																																				
Erosion									x										>							>					>	>		<	x	>
River meander	>	>																																		
Water flow-flood control, inundation frequency			>					>	>	>			>	>	>				>						>	>	>	>	>	>	>	>	>	>		>
Water flow-flushing flows			>							>															>	>	>	>			>	>				>
Water flow-hydroelectric generation			>							>																>	>	>			>	>				>
Water flow-withdrawals and diversions																										>	>									>
Preserve Use Issues																																				
Boating-safety and navigation								<		<																<	<									
Boating-use patterns								<		<																<	<									>
Fire management							>				>																	>	>	>						
Fishing																															>					
Houseboats																		>	>			>	>										>		>	>
Human waste disposal		>												>	>			>				>	>													
Hunting, poaching			<							<																		>	>							
Littering																																				>
Localized visitor impacts																																				>
Mineral extraction and transport (pipelines)	>										>	>					>		>											>	>	>				>
River access	>																																			>
Trash dumping																																				>
Trespassing	>	>																																		
Areawide/Neighbor Issues																																				
Agriculture	>		>										>						>		>		>					>	>	>	>	>				>
Burning-industrial and municipal											>																		>	>						>
Mineral extraction and transport (pipelines)											>	>					>		>												>	>				>
Paper Industry			>								>	>									>							>	>	>	>	>				>
Residential	>		>								>	>	>					>							>	>	>	>	>	>	>	>				>
Septic tanks													>					>																		>
Timber Industry	>		>								>					>			>									>	>	>	>	>				>
Administrative/Regulatory Issues																																				
Law enforcement																																	>			
State and Federal inconsistencies										>																					>	>				
User conflicts																																				

*Species Resources consider the number of species, changes in species, and the number of individuals represent widely varying levels and scopes of activities, so quantitative information on the degree of impact or priority of a given issue cannot be drawn from this matrix. Prior assessments based on characterization documents cited above indicate that for the water corridors, resources that are most important for their habitat value include: 1) *water (quality, quantity and timing);* 2) *woody in-stream substrate (snags);* 3) *stream banks*; and 4) *floodplain forest (amount and integrity).* Intact stream banks are particularly important to the scenic and aesthetic values as well as the ecological values of the Preserve's water corridors. The matrix can be used to identify those natural resource characteristics that are affected by the greatest number of issues relating to ecosystem alteration, public use, or institutional actions. This is one way of indicating which natural elements are threatened.

Water (quality, quantity and timing). Water is clearly the most important resource within the water corridors. Both quality and flow are important aspects of the water resource for habitat, species and human use. There is abundant local rainfall, ranging from an average of 36 inches annually in the northwest (well north of the Preserve) to 55 inches annually in the southeast part of the Neches Basin (ANRA 1992, LNVA 1994). The Neches River and its tributaries, including the Angelina River, drain an area of about 10,000 square miles (LNVA 1992). (Menard Creek is a small tributary of the lower Trinity River, which shares many characteristics with the Neches watershed.) Substantial impairment of either quality or quantity of water in the corridors, or major alterations in the timing of flows, will significantly affect the ability of the Preserve to maintain its current ecosystem function and exhibit its current biological diversity.

On the whole, water quality in the Preserve is good, although sampling has indicated some localized impairments (Hall and Bruce, 1994). It appears that where quality is diminished, it may be related to nearby human activities, such as residential developments or oil and gas production. Flow of the Neches River has been altered by the operation of Sam Rayburn Reservoir on the Angelina River just above the confluence of the Angelina and Neches Rivers and Lake B. A. Steinhagen (also called "Dam B" or Town Bluff Dam) on the Neches River just upstream of the Preserve. Effects of dam operations on the floodplain forest have been noted (Hall, 1994). The traditional attraction of the water resource for the public has continued to the present. Boating and fishing in the water corridors represents one of the most prevalent public uses of the Preserve (Callaway, 1994).

Woody in-stream substrate (snags). River bank erosion and natural tree growth cycles result in the fall of dead trees and branches into the watercourses. Snags in the river or stream provide cover for fish and also serve as a stable habitat for invertebrate populations, which provide food for fish (Hall and Lambou 1990 in Harcombe et al 1996). The importance of submerged snags is illustrated by a study conducted for the Satilla River (Benke et al 1979 in Harcombe et al 1996). It was estimated that removal of all the snags in the Satilla River would eliminate approximately 40% of the insect population, with insects accounting for about 80% of the animals that are in drift in the stream. Since many fish depend almost entirely on a food base of drifting invertebrates, the authors conclude that snag removal in the Satilla would be likely to result in a significant reduction in the fish population. They estimate that in some species, the population could drop as much as 50%, and a few species would be eliminated entirely. Comparison of the habitat value for aquatic invertebrates of snags relative to sandy or muddy stream bottoms indicates that snags support greater biomass and a more diverse group of macroinvertebrates than the stream bottom (Benke et al 1984 in Harcombe et al 1996).

From a species or habitat resource perspective, the presence of submerged snags is unequivocally beneficial. However, from a human use perspective, snags may be a hindrance. Residents of areas near BTNP streams point to debris collected in and around snags as a possible cause of increased flooding. Fallen trees are sometimes submerged wholly or partially and present obstacles that boaters interpret as safety hazards. Boaters, including park law enforcement personnel who must patrol the water corridors, have suggested that some snags be removed in the interest of boating safety (personal communication with NPS staff). The need for user safety and minimization of legal liability must be evaluated within the need to protect the ecological integrity of the BTNP water corridors by preserving submerged snags (Callaway 1994).

Stream banks. Intact stream banks are particularly critical to the ability of the BTNP water corridors to function as a showcase of a natural setting. To the extent stream banks have been altered by human activities such as trash dumping, rip-rapping to prevent streambank erosion, ill-placed septic system outfalls, or other man-made structures, they have diminished capacity to provide the scenic or aesthetic experience of a back-country boating or canoe trip.

The destruction of vegetation on the stream banks may also have habitat and species resources effects, possibly for reptiles and amphibians, and it certainly has an effect on future streambank erosion. Streambank erosion, in turn, deposits additional sediment into the stream, affecting water quality.

Floodplain forest. The floodplain forest communities in the stream corridors perform three primary roles: 1) habitat/refugium for bottomland hardwood forest species; 2) population dispersal conduits within the landscape; and 3) buffers for the protection of the aquatic community in the streams (Harcombe et al 1996). Characteristics of a functioning bottomland hardwood forest have been identified as:

1) a mature forest canopy of predominantly mast-producing species;
2) abundance of buttrot, bole, and branch cavities;
3) periodic flooding with the deposition of rich alluvium;
4) large-sized tracts so as to maintain viable populations of interior species;
5) natural transition zones between bottomland hardwood forest and adjacent uplands;
6) large enough area so as to sustain the dynamics of natural disturbance processes: windthrow, insect outbreaks, etc.

If the above ecological characteristics are diminished by human activity, the integrity of the bottomland hardwood forest and the associated aquatic communities decline (Harcombe et al 1996).

Fragmentation resulting from different activities such as land clearing or barrier construction associated with agriculture and silviculture, road, pipeline and utility construction and residential development has varying ecological impacts. However, in general, habitat fragmentation has two major interrelated consequences for biological diversity: 1) population isolation and decrease in effective population size, and 2) creation of edge habitat and its effects. Both population isolation and edge effects are related to the size and shape of the fragmented forest area (Harcombe et al 1996). Because the edge-to-interior ratios for the water corridor units of BTNP are extremely high, the effect of edges is of prime concern in limiting the role of the units as functional bottomland hardwood forest preserves (Harcombe et al 1996). Edge-to-interior ratios (computed as the ratio of land/water area within one-quarter mile of a boundary to the land/water area that is one-quarter mile or more from a boundary) within the water corridors of the Preserve can be high. For example, Little Pine Island Bayou Unit is all edge (2,270:0); Lower Neches River Unit is high (600:1), as is the Upper Neches River Unit (40:1). In contrast, the land units of the Preserve range from 13:1 (Hickory Creek Unit) to 0.5:1 (Big Sandy Unit). Although likely consequences of high edge-to-interior ratios have been identified, the effects of fragmentation on the ecology of bottomland hardwood forests have been virtually unstudied (Harris 1988a in Harcombe et al 1996).

Very little is known about the effectiveness of the corridors for the movement of birds and mammals within landscapes on the scale of BTNP, where corridors extend kilometers rather than meters. In general, wider corridors decrease the risk of invasion from feral animals and thereby reduce predation. Narrow corridors have the problem of being one long continuous edge zone. This edge increases the exposure of animals in the corridor to human contact, facilitating poaching and invasion by domestic and exotic species. Little research has been done to establish minimum widths for corridors to facilitate use by animals. Birds use migration corridors in other parts of the world (Saunders and de Rebeira 1991 in Harcombe et al 1996). However, it is not known to what extent the water corridors are used by birds for movement between units of BTNP (Harcombe et al 1996). No studies of BTNP corridor use by reptiles or amphians have been conducted (Harcombe et al 1996).

1.6 Management to Protect Critical Resources

Critical resources are those characteristic natural resource components of the ecosystem that may be threatened by human activity. The management topics presented in this document reflect this focus on critical resources of the BTNP; the topics fall into three basic categories: 1) those directly involving natural resources of the Preserve; 2) those involving members of the public using the Preserve; and 3) those involving the wider institutional and organizational context of the Preserve.

2.0 Resource Protection

As an overall goal, the Preserve should be managed to maintain to the maximum extent possible the integrity of its ecosystem components. This goal is consistent with the mission and authority of the Preserve.

Authority. The enabling legislation for the Preserve clearly assigns the task of resource protection to the NPS. The Service is directed to manage the units of the Preserve "in a manner which will assure their natural and ecological integrity in perpetuity" (P.L. 93-439, October 11, 1974; 88 Stat. 1254).

Background. BTNP was created to preserve representative remnants of an ecosystem that is threatened with modern development. At the same time, human activities that have existed in the area for many years were specifically mentioned and provided for in the enabling legislation. As a result, the option of totally prohibiting some human activities that may impact the natural resources is not present. Nevertheless, the natural resources of the Preserve should be managed in a manner that, to the maximum extent possible, preserves the integrity of its ecosystem components.

2.1 Biodiversity

The Big Thicket was set aside in recognition of its high biodiversity. Further recognition is evidenced by its designation as a "Man and the Biosphere Reserve" by the United Nations in 1981 (US Department of State, 1994). Because of the large number of species, some of which are listed as threatened or endangered (Harcombe et al 1996), protection of this biodiversity is of special concern. Furthermore, species diversity within the Preserve is an important indicator of ecosystem integrity; the presence of threatened or endangered species indicates an important responsibility to maintaining worldwide biodiversity. Assessments of diversity of major species groups (see references in Harcombe et al 1996) suggest regional declines in fish and some stream invertebrate groups, probably owing to regionwide modifications of waterways. For other groups, less specific information is available. There are broadscale trends in the southeastern United States suggesting that declining biodiversity is a concern.

For example, many amphibian species worldwide are believed to be experiencing population decline, range reduction, and possible extinction (Blaustein and Wake 1990 in Harcombe et al 1996) at least partly because of habitat decline and waterway acidification. Water corridors in general may have a special role in facilitating amphibian recolonization because their life cycles are dependent upon water (Blaustein et al 1992 in Harcombe et al 1996). Although no amphibian population studies have been carried out in the Preserve (Harcombe et al 1996), the potential of the Preserve to contribute to maintaining worldwide biodiversity suggests that studies should be conducted to document habitat requirements and population trends of amphibian species within the Preserve.

Similarly, the numbers of neotropical migrant birds have diminished. It is not known whether this is more the result of habitat destruction and fragmentation of breeding grounds in the U.S. or from deforestation of wintering grounds in the tropics (Terborgh 1989 in Harcombe et al 1996). It is known that the extinction of one neotropical migrant that formerly bred in the Big Thicket region was coincident with the loss of bottomland forest and the increase of open fields in the Southeastern coastal plains (Harris 1988b in Harcombe et al 1996). The degree to which the stream corridors serve as migration routes between BTNP units or between other areas is not known.

Impacts to water corridor resources. Biodiversity is affected by both habitat resources and species resources of the BTNP (see Figure 2). The reciprocal is also true: declining biodiversity reduces species resources, and therefore by definition negatively affects ecosystem integrity.

Recommended management actions. To address the issue of declining biodiversity, the NPS should:

1) continue to support the mission of maintaining ecological integrity of the Preserve;

2) carry out and support an active research program to assess and manage for biodiversity;

3) encourage neighbors to adopt management practices and land uses that help protect BTNP biodiversity.

Considerations for NPS research. Studies are needed to address declining biodiversity issues including:

1) understanding species habitat requirements and documenting population trends;

2) understanding community structure within the corridors; and

3) determining if the water corridors effectively function as movement corridors.

2.2 Endangered Species

As a federal nature reserve, BTNP has a legal responsibility to manage for threatened and endangered species that may rely on habitat within the Preserve. Harcombe et al (1996) detailed the threatened and endangered species historically known to occur in the counties in and around BTNP. Appendix A lists these threatened and endangered species; a brief summary follows.

Birds that are threatened and endangered that may occur in the BTNP water corridors include Bachman's sparrow *(Aimophila aestivalis)*; the wood stork *(Mycteria americana)*; the ivory-billed woodpecker *(Campephilus principalis)*, believed extinct; and Bachman's warbler *(Vermivora bachmanii)*, believed extinct. The red-cockaded woodpecker *(Picoides borealis)* is found in the area of the Preserve, but nests in pines rather than bottomland hardwood forests (Harcombe et al 1996). The floodplain forests within the water corridors provide habitat and possible serve as migration corridors for these and other non-threatened species of birds, including several waterfowl.

Among the mammals, two species of bats found in the Big Thicket are listed as threatened in Texas and are being considered for federal protection: the southeastern bat *(Myotis austroriparius)* and Rafinesque's big-eared bat *(Pleocotus rafinesquii)*. The endangered red wolf *(Canis rufus)*, which once existed in the BTNP area is now believed extinct (Harcombe et al 1996). The endangered Louisiana black bear *(Ursus americanus luteolus)* has not lived in the BTNP area for many years, but the area is being actively studied for a reintroduction program by the Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service.

BTNP floodplain forests may serve as habitat for several threatened, endangered, and candidate reptile and amphibian species. These include the Louisiana pine snake *(Pituophis melanoleucus ruthveni)*, the Texas garter snake *(Thamnophis sirtalis annectens)*, and the timber or canebreak rattlesnake *(Crotalus horridus)*. Two endangered turtles are found in the BTNP: the alligator snapping turtle *(Macroclemys temminicki)* and the Texas diamondback terrapin *(Malaclemys terrapin littoralis)*. Although the extent to which a worldwide decline in amphibian populations is shared by the Preserve has not been documented; the importance of riparian habitat to these species suggests that amphibian populations are an important consideration in managing water corridor resources.

The Paddlefish *(Polyodon spathula)* is listed as endangered by the State of Texas (Harcombe et al 1996). "The waters of the corridor units are both habitat and migration routes for this species of fish," which have been observed in the Lower Neches River (Seidensticker 1994 and Bounds et al 1981 in Harcombe et al 1996). NPS is cooperating with the Texas Parks and Wildlife Department (TPWD) to restore paddlefish populations to a level that will sustain recreational fishing (Pitman 1992a in Harcombe et al 1996). On the Neches River, TPWD plans to annually stock paddlefish downstream of Steinhagen Dam. If the program is successful, fish spawned in the upper river will eventually migrate downstream. As a result of the paddlefish restocking program, the use of gill, hoop, and trammel nets by sport or commercial licensees is no longer permitted by TPWD on the Neches River.

Among threatened or endangered plants, the Texas screwstem *(Bartonia texana)*, Texas least trillium *(Trillium pusillum* var. *texanum)*, Navasota ladies' tresses *(Spiranthes parksii)*; and Scarlet catchfly *(Silene subciliata)* are found in the water corridors. Navasota ladies' tresses and Scarlet catchfly are federally listed as endangered. Several other plants that are extremely rare or imperiled in Texas occur in habitats such as the water corridors: Lady cress *(Armoracia lacustris)*; White firewheel *(Gaillardia aestivalis* var. *winkleri)*; Rattlesnake root (Prenanthes barbata); Bog buttons *(Lachnocaullon digynum)*; Small-headed pipewort *(Eriocaulon kornickianum);* and Harvest lice (Agrimonia incisa). The Texas trailing phlox *(Phlox nivalis* var. *texensis)* which is listed as endangered at both the state and the federal levels occurs within the Preserve, but not in the water corridors.

Impacts to water corridor resources. Endangered species issues affect both Habitat Resources and Species Resources of the BTNP (see Figure 2).

Recommended management actions.

- Consider impacts of human uses of the Preserve on resident threatened and endangered species.
- Continue to support protection of threatened and endangered species by cooperating with the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department and by implementing USFWS recovery plan criteria for threatened and endangered species known to occur in the Preserve.

Considerations for NPS research. Specific research needs related to threatened or endangered species include:

1) mapping potential habitats of threatened and endangered and candidate species;
2) conducting field surveys of populations;
3) monitoring species known to inhabit the Preserve.

2.3 Exotic Species

The negative effects of non-native species invasion have been documented in a number of cases. Mammal species introduced to BTNP include the nutria, feral cat, feral dog and feral hog (Harcombe et al 1996). These animals directly compete with native species for food and habitat. There is a concern that feral hogs may be damaging plants by wallowing near and foraging on bottomland mast-producing tree species (comments of BTNP Resource

Management staff, 1995).

Within the water corridors, exotic species that may become a concern include the grass carp, zebra mussels, non-native aquatic vegetation and the Chinese Tallow tree. In other areas of southeast Texas, grass carp (introduced to control vegetation in ponds and reservoirs) have damaged native aquatic vegetation, diminishing the habitat of aquatic species and encouraging bank erosion (Chilton 1995). The spread of Zebra mussels across waterways in the U.S., with the Zebra mussels outcompeting native aquatic species, has been a concern for state officials (personal communication with Larry McKinney, TPWD). The water hyacinth has for many years grown prolifically in low-flowing southern U.S. waters, choking out native species and degrading water quality by lowering dissolved oxygen levels (Johnson 1995). The Chinese Tallow is proliferating in many native bottomland hardwood areas (Cameron et al 1995a; Bruce et al in press).

All of the water corridor units have the potential for non-native species invasion. The Neches River and its tributaries within the Preserve may be susceptible to the introduction of exotic aquatic species such as the grass carp and zebra mussel.because of their connection to the Gulf Intracoastal Waterway. The fierce competitive nature of these introduced species may result in lowered natural biodiversity in the Preserve.

Impact to water corridor resources. The introduction of exotic species to the water corridors of the BTNP affects both Habitat Resources and Species Resources. Specific habitat characteristics affected include: submerged aquatic habitat, streambank (emergent) vegetation, and water quality. Species resources currently affected include aquatic invertebrates and bottomland hardwood forests.

Recommended management actions. Many of the actions needed to control introduction of exotic species to BTNP are not within the purview of the NPS. NPS can support the efforts of the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and the U.S. Natural Resources Conservation Service to prevent introduction of and to control the spread of exotic species.

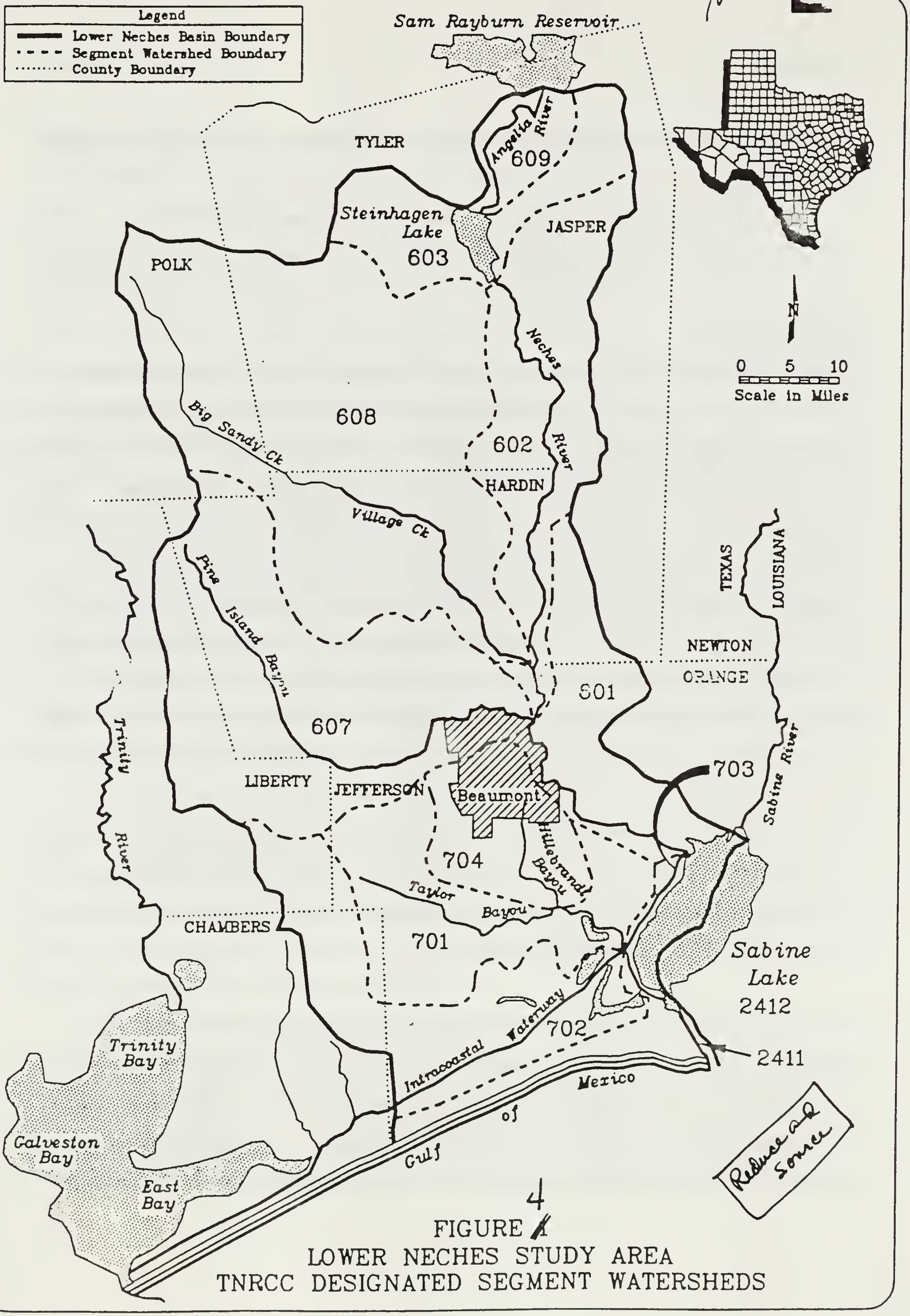
Considerations for NPS research. Information needed to address the introduction of exotic species include:

1) studies of distribution, invasiveness, and effects of exotics within BTNP;
2) research on means of preventing introduction of or controlling exotics in the BTNP.

2.4 Water Quality

Figure 4 depicts stream segments designated by the Texas Natural Resource Conservation Commission for watersheds around the BTNP. Water quality monitoring data indicate that declining dissolved oxygen levels may be a regional concern, and certainly are a concern for the Little Pine Island Bayou Corridor (Hall and Bruce 1996). The Pine Island Bayou watershed has the poorest water quality in the region; dissolved oxygen levels do not meet standards more than 10% of the time. Additionally, chlorides and fecal coliform levels, sulfate concentrations and total dissolved solids are high in the bayou (Hall and Bruce 1996; Kaiser et al 1994). Oilfield brines, municipal sewage discharge, and runoff from rice farming and residences are probable contributors to these conditions. Elevated levels of chlorides, apparently from oilfield brines, also are a concern for Menard Creek. Turkey Creek has some problem with fecal coliform, and the upper Neches River sampling sites registered high in total dissolved solids (Hall and Bruce 1996). Several studies have indicated that saltwater intrusion and industrial pollution carried into the Neches River impair the habitat value of the lower reaches of the river for benthic communities (Harcombe et al 1996). An analysis of trends from ten years of data collected by BTNP suggests that there has been a reduction in brine-related pollution (Hall and Bruce 1996).

As part of the National Bioaccumulation Study, the U.S. Evironmental Protection Agency (EPA) found concentrations of dioxin exceeding the accepted (10^{-4}) risk level in fish tissue samples from the lower Neches River downstream from Evadale (EPA 1990). The sampling site was approximately 1/2 mile downstream from the Temple-Eastex paper mill discharge canal. Based on the EPA findings, the Texas Department of Health issued a fish consumption



Reduce and Source

FIGURE ~~1~~ 4
LOWER NECHES STUDY AREA
TNRCC DESIGNATED SEGMENT WATERSHEDS

advisory for the lower Neches River below Highway 96 (see Figure 5). More recent samples show reduced concentrations of this toxin (Harcombe et al 1996). During 1994, 66 fish samples were collected from an area just below, but within swimming range of, the previous sample site and were examined for dioxin and a full suite of priority pollutants. Dioxin levels were below the acceptable risk level, but polychlorinated biphenyls (PCBs) in excess of the federal safety standard were found in one sample. Based on that finding, the Department of Health retained the advisory pending analysis of additional samples (Texas Department of Health, 1995). In 1995, six additional fish samples were collected for analysis (Lisa Williams, TDH, 1995). In December 1995, the advisory was removed (LNVA 1996).

In a regional assessment of streams in the lower Neches basin, very few areas of water quality concern were identified (LNVA 1996). Table 1 provides a summary of the water quality concerns (a revision of previous assessments) listed for streams in the BTNP. Similar data are not available for Menard Creek, which is in the lower Trinity River basin (personal communication with Dr. Richard Browning, TRA, 1996).

Table 1. Water Quality Concerns in the Lower Neches Basin
Source: LNVA Clean Rivers Program Regional Assessment of Water Quality, 1996

Stream Segment	Parameter	Classification
0601 - Neches River Tidal	Fecal Coliform	Possible Concern
0602 - Neches River	Cadmium	Insufficient Data
	Copper	Possible Concern
	Lead	Insufficient Data
	Mercury	No Concern
	Zinc	No Concern
0607 - Pine Island Bayou	Fecal Coliform	Possible Concern
	Dissolved Oxygen	Possible Concern
	Total Phosphorus	No Concern
0608 - Village Creek	Fecal Coliform	Possible Concern
	pH	No Concern
	Aluminum	No Concern

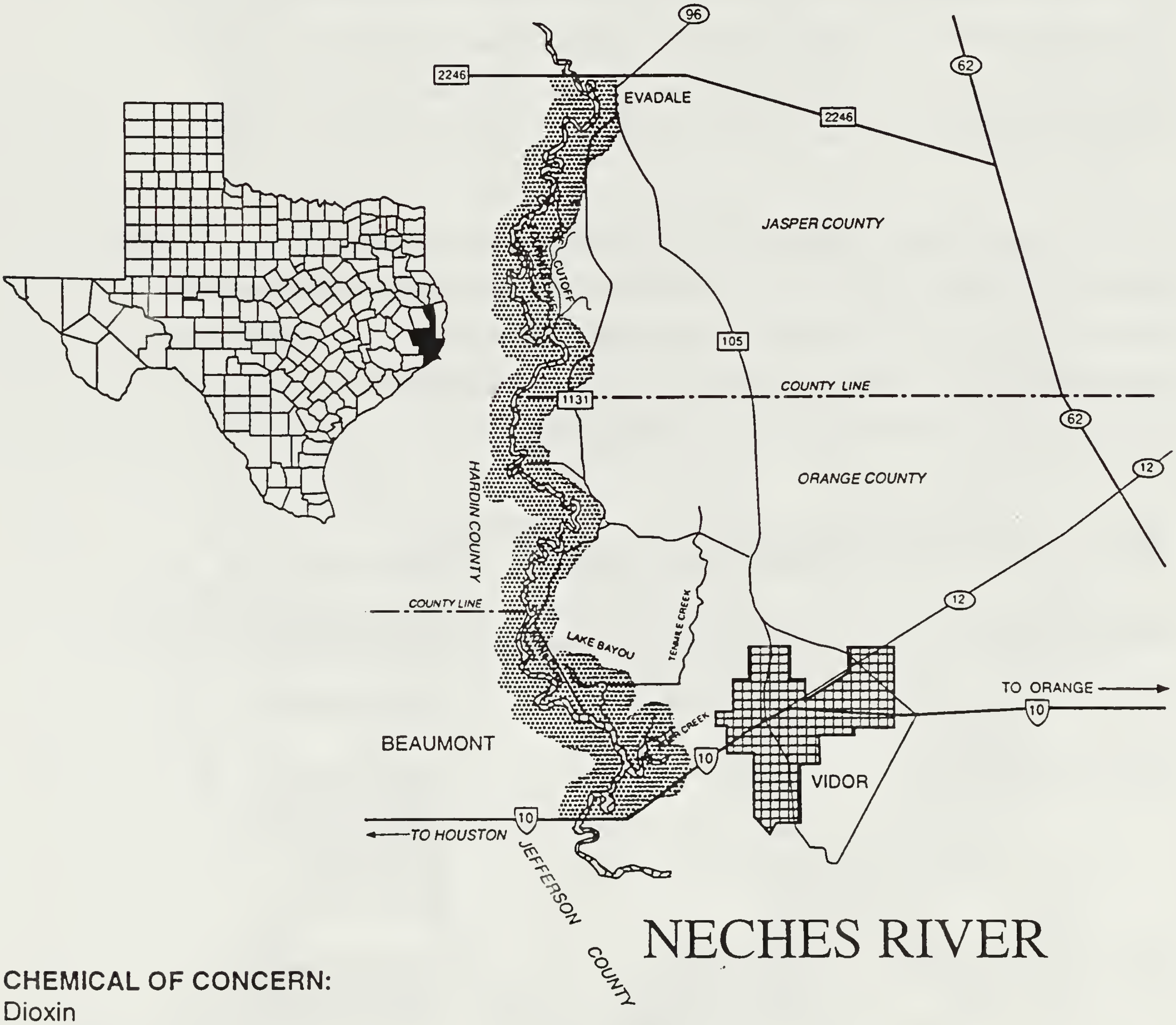
FIGURE 5. TDH ADVISORY AREA

NECHES RIVER

ORANGE, JEFFERSON, JASPER, AND HARDIN COUNTIES

ADVISORY AREA:

The Neches River and all contiguous waters south of the U.S. 96 Bridge near Evadale to the Interstate 10 Bridge near Beaumont



NECHES RIVER

CHEMICAL OF CONCERN:
Dioxin

CONSUMPTION ADVICE:
The advisory includes all species of fish and recommends consumption of no more than one meal, not to exceed eight ounces, each month. Women of childbearing age and children should not consume any fish from this area.

Impact to water corridor resources. Impaired water quality has effects on both Species Resources and recreational opportunities in the Preserve.

Recommended management actions. The water quality monitoring program should be supported and coordinated with data collection efforts of other state and federal agencies. Cooperative water quality sampling efforts with the Lower Neches Valley Authority (LNVA) should be pursued. Water quality data should be collected under a quality assurance plan that is approved by the Texas Natural Resource Conservation Commission to allow NPS data to be used in state and federal enforcement actions.

Considerations for NPS research. The data base established by the NPS should be maintained. Periodic analysis and reporting of the data should be performed.

2.5 Water Flow: Impoundments, Diversions, Releases

Principal alterations to water flow result from 1) impoundments, 2) diversions, and 3) timing of releases (Hall 1994). Unintentional changes to water flow may also be caused by the construction of roads and bridges or by urban development. Roads and bridges can act as large-scale wiers impeding and changing the course of natural runoff.

The construction and operation of Sam Rayburn Dam and Lake B. A. Steinhagen (Dam B) on the Neches and Angelina Rivers have changed the flow characteristics of the Neches River by reducing the frequency and duration of both high and low flows (Gooch, 1996; Hall 1994). Town Bluff Dam (Dam B), 113.7 miles above the mouth of the Neches River, at the upstream end of the BTNP Upper Neches Unit was completed in June 1953 and created a reservoir called B. A. Steinhagen Lake (U.S. Army Corps of Engineers, 1976). The U.S. Army Corps of Engineers operates the dam in conjunction with the much larger Sam Rayburn Reservoir, which was completed in 1965 and is located on the Angelina River about 25 river miles above Steinhagen. The Corps controls the timing and volume of releases from Rayburn/Steinhagen for the principal purposes of electricity generation, water supply and recreation on the lakes. Dam B and Steinhagen Lake function to ameliorate fluctuations in water flow related to hydropower generation at Sam Rayburn. The Texas Parks and Wildlife Department operates Martin Dies Jr. State Park on the northeastern shore of the Lake Steinhagen.

Changes in the duration and frequency of floods on the Neches River attributable to construction of the Rayburn/Steinhagen dams have resulted in changes in the species composition and distribution of floodplain forest communities (Hall 1994). Hydropower generation affects the timing of releases (Gooch, 1996-Table 6); however, no effects within the water corridors have yet been documented. Operating restrictions on pool elevations and on releases related to power generation as measured by flow rates at Evadale (U.S. Army Corps of Engineers, 1976) minimize the likelihood of short-term fluctuations in the Neches River below Dam B that would be detrimental to aquatic biota of BTNP.

One impact of lake and dam operations on the water corridors is the use of drawdowns and "flushing flows" to control nuisance vegetation (such as hydrilla, water hyacinth, and lotus) in Lake Steinhagen. In 1994, the BTNP registered complaints about the dead vegetation flushed into the Upper Neches Unit as a result of this practice (Callaway 1994).

Diversion measures may alter flooding frequency and duration by reducing (or increasing) the amount of water flowing through stream channels (Pearlstine et al 1985 in Hall 1994). An assessment carried out by the Lower Neches Valley Authority (LNVA) under the State's Clean Rivers Program found that currently permitted withdrawals from the water corridors do not appear to have any significant effect on water quality in the streams (LNVA 1994). Table 2 provides amounts of water diverted by the LNVA system for 1990 - 1993. Water is also diverted by the City of Beaumont for municipal purposes. Most of the diversion is at the south end of the Preserve and therefore does not substantially alter volume of flows within the water corridors. However, because the freshwater diversion points are near the tidal portion of the river (much of which has been channelized), saltwater intrusion is a periodic problem. The issues surrounding use of temporary saltwater barriers to combat saltwater intrusion are discussed below in section 4.4.

Proposed future withdrawals or transfers that involve crossing any of the water corridors may have substantial impacts on stream flow. Potential changes that may affect flow and circulation include water withdrawals associated with regional agricultural, industrial and municipal water use and water transfer projects such as the interbasin transfers being studied under the state's Trans-Texas Water Program (Callaway 1994), which is discussed further in section 4.5.

Impact to water corridor resources. Changes in the seasonality and peaking of flows on the Neches River have altered the floodplain forest (Hall, 1994). Manipulation of the lake water level to control the growth of aquatic vegetation may result in negative effects to habitat resources downstream from the dam on the Upper Neches River Corridor Unit. The flushing of dead vegetation after the lake is refilled may result in impairment of water quality (lower dissolved oxygen (DO) levels, odor problems) and diminished quality of scenic and aesthetic resources downstream on the Neches River; these probably are short-term impacts on water quality and nuisance to users. There is no known impact to important species resources.

Table 2. Total diversions by LNVA from the Neches River and Pine Island Bayou
Source: Dennis Becker, Lower Neches River Authority, 14 September 1994.

Year	Diversion (acre feet/year)
1990	349,911
1991	339,891
1992	381,264
1993	354,685

Permanent changes in the overall amounts and timing of stream flows may affect the stream corridors. Direct effects to habitat resources may include changes in channel morphology, rate of meandering, sedimentation and water quality, and the amount and type of submerged habitat. Secondary effects to species resources may include changes in growth, mortality and regeneration of vegetation along the riparian corridor (Hall 1994). Any of these changes together with associated structures on the stream banks may affect the scenic and aesthetic quality of the water corridors. Specific impacts of possible interbasin water transfers are unknown at this time.

Recommended management actions. The NPS should:

1) continue to actively participate on the Technical Advisory Committee of the Trans-Texas Water Program to ensure that avoidance of impacts to BTNP remains a principal criterion for evaluating alternatives. NPS should make certain that location and design of any proposed river crossings have no negative impact on water corridor functions and values.

2) monitor the timing of drawdowns and flushes and work with the COE to influence the operation of the Steinhagen Dam (Dam B) so that any negative impacts on the water corridors are avoided.

Considerations for NPS research.

1) Recent developments on the Colorado River above the Grand Canyon in Arizona indicate that it may be possible to affect the operation of dams that impact NPS water resources. Research into these possiblities is highly desirable.

2) To deal with the potential impacts of "flushing flows" from Dam B, the NPS needs the following information: a) water quality data for Upper and Lower Neches River; water quality surveys of Upper Neches during periods of flushing; and b) record of BTNP user reactions during periods of flushing -- either reports to rangers or special surveys.

3) The NPS needs to know the potential impacts of any stream crossings proposed by the Trans-Texas Water Program or other water supply plans.

2.6 Woody In-stream Substrate (Snags)

River bank erosion and natural tree growth cycles result in dead trees and branches falling to the watercourses. The fallen trees are sometimes submerged and present obstacles/hazards to boaters who would like to have the trees removed from the riverway. Law enforcement personnel also must contend with these obstacles in patrolling the waterways. Fallen trees are part of the natural habitat of aquatic species in BTNP. Removal of snags (or "desnagging") destroys that habitat. Removal of snags also allows water to flow more quickly and may contribute to streambank erosion.

The fate of snags is an issue affecting the Neches River, Pine Island Bayou, and Village Creek. Each of these water corridors has significant boat and canoe usage.

Impact on water corridor resources. Snag removal has substantial impact on submerged aquatic habitat and fish and invertebrate species resources of the water corridors. The presence of snags in the reaches of the streams that are used for boating can affect human use of the Preserve through a concern for boating safety.

Recommended management actions. To address the issue of snags, NPS should:

1) Review incident reports relative to boating safety to determine if there is a significant threat to human use of the water corridors.

2) Increase boater education about the presence of snags and their importance for habitat.

3) Consider identifying some areas as boating zones within which some snags will be removed for safety reasons.

4) Incorporate information on the importance of snags for aquatic habitat into general educational activities with area residents.

Considerations for NPS research. The importance of woody in-stream substrate (snags) has been documented in other locales. Similar research on the importance of snags as habitat to species in the water corridors would be helpful in supporting management decisions.

2.7 Stream Banks (Erosion and River Meander)

Intact stream banks are important to a high-quality scenic or aesthetic experience on the

Preserve's rivers and streams. Rivers are dynamic entities, eroding some areas and accreting others. This characteristic is particularly notable in the Neches River. Eroding banks are subject to further alteration as property owners neighboring the Preserve attempt to stem the erosion by placing rocks, concrete, or other materials on the banks. In addition to being unsightly, the destruction of vegetation on the stream banks may have a negative effect on habitat and species such as reptiles and amphibians. The loss of vegetation, whether man-caused or natural, results in additional erosion and an increased sediment load within the stream. This natural meander process also produces sand bars and banks in accreting areas which are popular for recreational activities.

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Because of the narrowness of the boundaries of the water corridor units and potential impact of river meander, boundaries of the Neches River units are designated in the enabling legislation for the Preserve by stream gradient boundaries for bank-to-bank inclusion (Fed. Reg. vol. 52, Mar. 17, 1975, Part II). Over time the Neches River has meandered from the original course existing at the time properties were acquired for the water corridors. Additionally, there are indications from field reconnaisance and Preserve staff that the river course in specific locations may have been purposely altered by human activity (Pers. comm., D. McHugh, BTNP, NPS).

Impact to water corridor resources. Natural river meander is occurring within the Preserve. However, minimal impact to the water corridors has been documented. Field observations have indicated substantial visual impacts in specific locales resulting from modifications to banks by nearby property owners in an attempt to control erosion.

Recommended management actions. The NPS should consider the following options:

1) continue legally defining water corridors, or at least the Neches River corridor units, in terms of stream-gradient-boundary for bank-to-bank inclusion in the Preserve;

2) identify areas in which river meander has the potential to create boundary problems and determine if management conflicts with neighbors are likely to arise;

3) acquire additional lands bordering the Neches River corridor units, particularly in

areas of active erosion, to bring more streambanks within Preserve management.

Considerations for NPS research.

1) The extent to which streambank modification has affected habitat for important species within the Preserve has not been adequately studied.

2) Information on alternative methods of stabilizing streambanks in areas with high rates of erosion, and educational programs that might inform neighbors of these methods, are needed to produce less intrusive bank stabilization practices.

3) Information needs relating to river meander include: a) assessment of rates of stream channel changes with maps of water corridors and stream paths over time; and b) property ownership information in areas in which meander is occurring.

2.8 Floodplain Forest Habitat

The water corridor units consist of two distinct biological communities: the bottomland hardwood forest community located on the floodplain terrace adjacent to the waterway and the aquatic community present within the active channels and connected oxbows. While these communities are fairly distinct, an important ecotone exists between these two communities, the streambank (Harcombe et al 1996). The biological integrity of one of these, the aquatic community, is highly dependent upon the extent of bottomland hardwood hardwood forests both inside and outside the Preserve. Therefore, the integrity of the corridor units is strongly challenged by the fragmentation associated with land use practices within and adjacent to the corridor unit. Pipelines, roads, agriculture, timber harvests, and residential developments all occur in the vicinity of the Preserve, creating pressures to reduce the total amount of bottomland hardwood forests and contributing to fragmentation of the floodplain forest habitat.

Impact on water corridor resources. The principal ecological impacts of habitat fragmentation are 1) population isolation and a decrease in effective population size, resulting in the possible loss of some species, and 2) the creation of edge habitat and "edge" effects such as change in microclimatic conditions, increased predation and roadkills in open areas, and increased human access.

Recommended management actions.

1) Make certain that NPS facilities minimize fragmentation within the Preserve.

2) Participate in public planning activities, such as those for road construction, to prevent avoidable fragmentation and negative habitat impacts from neighboring uses.

3) Continue working with the oil and gas and pipeline companies in accordance with the Oil and Gas Management Plan to minimize the impact of their activities within or near the Preserve on habitat.

4) Encourage neighbors to adopt management practices and land uses that minimize additional fragmentation of bottomland hardwood forests.

Considerations for NPS research. There are many questions unanswered about habitat quality and the effects of fragmentation on the BTNP. Among them are:

1) How does aquatic diversity respond to increased width of the forest strip in the corridors?

2) What are the specific impacts of neighboring human land uses on water quality, species diversity and corridor integrity?

3) In the corridor units, what is the relative importance of quality of water as it enters the corridors versus characteristics of the forested buffer zone in contributing to in-stream habitat quality?

2.9 Aesthetic/Scenic Qualities

There have been no landscape-level studies of the BTNP. Studies of archaeological and cultural resources (see below) have identified specific sites, but no larger communities or cultural landscapes are known to exist in the corridor units. The major public uses of the Preserve (fishing, boating, hunting, hiking, backcountry camping) all reflect an appreciation for undeveloped, backcountry-type experiences. Partly as a result of this, scenic quality is an important condition of streambanks along the water corridors. Village Creek is a popular stream for canoists because of its pastoral qualities. There are long reaches of the Neches

River which are uninterrupted by development and which are extremely scenic. For the areas in which the NPS does not own the streambanks, neighboring uses have a great impact on the quality of recreational experience provided by the water corridors. Based on field observation during 1993, these scenic qualities are most seriously diminished in residential areas where banks have been altered, usually in an effort to prevent erosion.

Impacts to water corridor resources. Any diminution of the scenic quality of the water corridors is likely to decrease public use and enjoyment of the Preserve. Furthermore, the condition of the streambanks has ecological importance as well as aesthetic value (see discussion of critical resources above).

Recommended management actions.

1) Work with neighbors in residences along river and stream banks to preserve the scenic quality of the corridors and discourage unsightly stream bank alterations.

2) Work with appropriate governmental units to prevent avoidable intrusions and minimize effects of unavoidable facilities such as roads and bridges.

3) Work with pipeline companies to minimize the visual impacts of pipeline crossings.

Considerations for NPS research. None at this time.

2.10 Archeological and Cultural Resources

The NPS is required to comply with federal laws and regulations that provide for identifying, evaluating, and protecting archeological and cultural resources (NPS 1988a, 5:1-15). Principal among these federal laws are the Antiquities Act of 1906 (16 USC 431-433, 1988); the Historic Sites, Buildings and Antiquities Act of 1935 (16 USC 461 et seq., 1988); the National Historic Preservation Act of 1966 (16 USC 470 et seq., 1966); and the Archaeological Resources Protection Act of 1979 (16 USC 470aa, 1988).

General surveys of archeological and cultural resources of BTNP were undertaken in 1975.

Since that time, only small area surveys associated with specific projects such as oil and gas pipeline construction have been added.

Shafer et al. found twelve archeological sites "within or near" the BTNP boundaries, mostly on "elevated landforms such as abandoned stream levees, terrace remnants and upland features located in the proximity of larger streams or rivers." (Shafer et al. 1975). Most sites were placed in the early ceramic period (about 200 B.C.) or later. One site also showed evidence of early European influence, perhaps a small settlement. The Final Environmental Statement for Establishment of the Big Thicket National Preserve, Texas indicates that seven of the sites Shafer et al. identified were within Preserve boundaries, and only one of those was possibly a "significant site" -- the De Gave site in or near the Lance Rosier Unit (NPS 1976).

An interesting aspect of Shafer et al.'s work was an extensive analysis of the factors that might explain the "paucity" of aboriginal sites observed. These are summarized as:

1. Proposed boundaries include mostly bottomland and swamp -- elevated landforms where habitation might be expected occurred outside the boundaries.

2. Cultural material may be buried so deeply under soil and humus that evidence cannot be detected on the surface. This explanation was advanced particularly for the Neches River.

3. Landowner denial of access prevented inspection of some areas.

4. Aboriginal populations may have used the Big Thicket area for hunting or water transportation, but these activities leave little for the archaeological record.

5. The meander pattern of the lower Neches River has resulted in the loss of archeological sites.

Based on their findings, Shafer et al. recommended a "thorough survey" upon purchase of the BTNP lands. Because of the configuration of individual preserve units, a watershed approach to surveying, including both public and private lands, was recommended (although the authors on several occasions noted the difficulty of gaining land owner access to many of those lands). Also suggested are a description of the Quarternary geology of the area and a pollen analysis of the peat bogs in and near the BTNP. In summarizing, Shafer et al. point out that the BTNP was established because of its "unique botanical resources" and that while archeological resources are present, they do not "warrant a priority for interpretative development" (Shafer et al. 1975).

Dethloff and Treat surveyed historical resources of the Preserve in 1975 (Dethloff and Treat, 1975). At that time, no historic sites or structures in Hardin, Jasper, Liberty or Polk counties were listed in the National Register for Historic Places or were suggested by the Texas Historical Commission for inclusion in the Register. Dethloff and Treat included in their survey "buildings, sites and structures in the general vicinity of the Units, although in some instances these locations were 10-20 miles away from the Preserve boundaries" Much of their report emphasizes the general history of southeast Texas to provide a "general historical orientation of the Big Thicket." The General Management Plan for the BTNP lists three structures or sites as "worthy of notation", two of which are in water corridor units:

Richardson house, a pioneer home in theTurkey Creek Unit
Voth mill, remains of a steam-powered lumber mill in the Beaumont Unit
Old Yellow Bluff ferry site in the Neches Bottom/Jack Gore Baygall Unit.

The Dethloff and Treat team concluded that it described "practically all" structures within the Preserve, but suggest that additional unmarked burial plots or former river landings or ferry crossings may yet be found. The implication of their study is that there may be high potential for future historical study and development of interpretive materials within the Preserve in an examination of river landings or ferry crossings within the Neches River corridor units. An NPS report titled "Discovery of a Neches River Ferryboat, Big Thicket National Preserve, Tyler County, Texas" by James E. Bradford (1992) was not available for review at this time.

A project-specific survey within the Beaumont Unit in 1994 discovered no additional archeological or cultural sites (Moore and Aronow, 1994).

Impacts to water corridor resources. The two cultural sites that have been identified within the water corridors are not developed to encourage visitation and accordingly have little impact on the natural resources of the corridors.

Recommended management actions. Consideration should be given to improved public presentation (printed materials and displays) of archeological and cultural information already in the possession of the NPS.

Considerations for NPS research. No archeological/cultural research needs have been identified within the water corridors.

3.0 Public Use of the Preserve

Public use issues are those that occur within the BTNP boundaries and frequently involve members of the public. The 1916 NPS organic act (16 USC 1) provides the basic mission of national parks and preserves as providing for public use and enjoyment while leaving the resource unimpaired for future generations (NPS Management Policies, 1988 8:1). Although the BTNP was authorized in 1974, it is a relatively young park facility. To date, unlike many older, more well-known national parks, the Preserve is not generally faced with problems of overuse by park visitors. One explanation frequently given for this is the difficulty in identifying the 15 widely dispersed units as a visitor destination. For much of the general public, the Visitor Information Station at the Turkey Creek Unit is the BTNP.

Monthly counts of visitors to BTNP units are made by Park Rangers and compiled by the Division of Interpretation (Callaway, 1996). However, the entire length (87 miles) of the Neches River is treated as one facility and Lakeview Beach (sandbar) is treated as another in visitor counts. No counts are made for Menard Creek. It is uncertain whether Little Pine Island Bayou/Pine Island Bayou Corridor visitation is included within counts for the Lance Rosier Unit. Table 3 provides available visitor counts by facility since 1982. Preserve visitation peaks in October annually, coinciding with hunting season (Callaway 1996). A secondary peak is experienced in July for the Neches River. For all units, the month of lowest visitation is February.

During 1992, a 2% sampling was made of visitors to the Turkey Creek Visitor Information Station. Data collected indicated that the vast majority (85%) of visitors surveyed were from Texas, were Anglo (96%), and were visiting the Preserve for the first time (76%) (Callaway 1996). It is not probable that these first-time visitors have the same profile as boaters and fishers who use the water corridors, who are generally thought to be residents of the region and repeat visitors to the BTNP. Fishing is reported by the Texas Parks and Wildlife Department to be more important than walking for recreation in the Deep East Texas region that includes much of the BTNP (TPWD 1990 in Callaway 1996).

TABLE 3. BTNP VISITOR COUNTS

BIG THICKET NATIONAL PRESERVE
HISTORICAL DATA ON VISITATION TO FACILITIES/AREAS

~~II~~. FACILITY VISITATION BY YEAR

FACILITY / YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Information Sta	7480	8853	8584	7269	9727	10908	2726	13414	10829	12735	13469				
Kirby Nature Tr	8005	7630	10965	6645	7496	7308	506	7383	7211	2683	2722				
Sundew Trail	1198	3425	3591	2508	3426	3585	1868	2559	3328	3422	3186				
Beech Woods Tr	711	1086	1668	1637	1076	1376	1674	1112	1056	762	918				
Pitcher Plant Tr				2447	2495	2746	946	2222	2202	2180	1646				
Turkey Creek Tr	4531	2618	3951	2358	2508	2830	1634	4165	3946	2452	1838				
Woodlands Trail		374	1518	1280	926	1392	2470	1514	1536	1300	1354				
Jack Gore Baygall	6565	2370	13298	6796	9808	8123	1496	16545	8063	5084	3892				
Lance Rosier Unit	10957	3509	8515	8540	4443	4716	5865	23356	6250	6742	4246				
North Dist Other	2504	1995	2356	1699	1996	2151	632	8417	3254	2000	2188				
South Dist Other	3551	3262	14088	19670	21573	11267	4927	15706	17158	14164	18541				
Headquarters	3816	2768	3744	4485	2507	1683	1241	889	807	974	1368				
Lakeview Beach			14750	15575	3267	9385	1334	7361	13057	6747	11086				
Neches River						42	314	1857	3446	2087	3748				
Backcountry	290	289	593	540	392	471	726	759	1307	1565	1523				
Big Sandy Horse Tr									240	408	544				
TOTAL	49608	38179	87621	81449	71640	67983	28359	107259	83690	65305	72269				

SOURCE: BTNP, Monthly Public Use Report, NPS FORM 10-157.

A recent survey of several conservation and recreation groups who were expected to be more knowledgeable than the general public of the BTNP, found that 95% of respondents had visited one or more units of the Preserve. Seventy-three percent had visited the Information Center and Turkey Creek Unit, while 85% had visited Village Creek, a water corridor unit (Callaway 1996). This level of use found among an attractive target population indicates that a supportive audience exists within the region for getting out the message of the BTNP.

As part of its mission to provide natural resource education, the Division of Interpretation works actively with area schools and exploits other opportunities to reach beyond the current audience. Approximately 6,000 schoolchildren visit the Preserve annually as part of cooperative programs between BTNP and area school districts and an additional 4,000 are reached through in-school visits (Personal communication with R. Valen and L. Dubay, BTNP, NPS). While these activities are rarely centered on the water corridors, they raise general appreciation of the intrinsic worth of the Preserve's resources and they introduce members of a new audience to existence of the BTNP. New programs have been initiated to reach particular groups, such as boaters, with both resource interpretive and safety information.

The issue of resource carrying capacity has been discussed by Preserve staff, but the current level of public use has not made it an urgent issue. The importance of identifying baseline conditions and building data bases that will support future mangement decisions has been recognized. Additional information on public use, as well as natural resources, within the water corridors will be needed to manage the water corridors.

Impact to water corridor resources. The current level of public use does not appear to have negatively impacted water corridor resources. The potential for specific activities to affect specific resources or for some public uses to conflict with other public uses has been discussed in preceeding sections.

Recommended management actions. Place more emphasis on collection of data on visitation (such as visitor counts) and add sites as appropriate to better describe visitation within the water corridors.

Considerations for NPS research. Develop a survey to be administered periodically at river access points to develop better information about users of the water corridors.

3.1 Hunting and Trapping

Hunting and trapping are recognized as legitimate uses of a park under certain circumstances. NPS Management Policies (NPS 1988a, 4:7) state that "hunting and trapping wildlife will be allowed only in parks where such use is specifically authorized." In such cases, the NPS will still seek "to perpetuate native animal life and to protect the integrity of natural ecosystems." Further, management programs "will be conducted through cooperative efforts with individual states under memoranda of understanding." Hunting and trapping (8:4)

> will be conducted in accordance with federal law and applicable laws of the state or states where the park is located. However, the National Park service may establish regulations or closures that are more restrictive than applicable state regulations based upon a finding that such restrictions are necessary for public safety, resource protection, or visitor enjoyment. Before regulations or other restrictions are implemented by the Park Service, representatives of appropriate state and federal agencies will be consulted. Any such regulations or other restrictions will be developed with public involvement.

36 CFR 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). 36 CFR 2.2(c) provides that the superintendent will consult with appropriate State agencies before invoking the authority given in section 1.5 except in cases of emergency or areas of exclusive federal jurisdiction. 36 CFR 2.2 addresses wildlife protection and section 2.2(b) specifically addresses hunting and trapping.

The Big Thicket National Preserve Establishment Act of 1974 [PL93-439, Sec. 4(c)] directs that hunting and trapping be permitted. The intent was to allow (protect) the continuation of traditional uses of wild lands of the Big Thicket. These activities may be restricted to certain areas or times for reasons of public safety, administration, resource protection, or public use and enjoyment. Except in emergencies, hunting and trapping restrictions "shall be put into effect only after consultation with the appropriate State agency." For BTNP, this is the Texas Parks and Wildlife Department.

The BTNP General Management Plan (NPS 1980, p.47) recognizes the requirements of PL93-439 and directs that the NPS "will establish an action plan for hunting, fishing, and trapping management" to provide for resource protection and visitor safety. The Plan states (p. 49) that the hunting, fishing, and trapping management action plan will determine the intensity and yearly distribution of hunters and fishermen.

The BTNP Final Draft Statement for Management (NPS 1995a, pp. 16-17) recognizes "hunting and the carrying of weapons in the Preserve" as a "major and continuing issue" affecting visitor safety, resource protection, and neighboring uses. The statement notes a shortage of law enforcement rangers for effective monitoring and enforcement and provides that public education efforts will be continued as resources permit.

36 CFR 7.85 sets out Special Regulations for BTNP and addresses regulations for hunting, trapping, and weapons possession and use. Sec. 7.85(c) provides that in addition to State permits, permits will be issued by the Preserve.

BTNP Standard Operating Procedure (Superintendent's Orders) 94-7141-02 (NPS 1994a) establishes Preserve procedures for the hunting and trapping programs. Section 1.5(a)(1) provides that there will be no hunting in any Water Corridor Unit except the Neches Bottom/Jack Gore Baygall Unit and the Beaumont Unit.

Annual Hunting Regulations establish the hunting season and areas of the Preserve in which a BTNP hunting permit is valid. The Regulations establish restrictions on hunting within 500 feet of a road or waterway. Maps incorporated in the hunter education packet accompanying the permit indicate the boundaries of the hunting areas within each of the Preserve units.

Background. Public hunting and trapping was initiated in 1979 by permit only after consultation with the Texas Parks and Wildlife Department (NPS 1988b; NPS 1975). All hunting and trapping is done in accordance with State regulations as directed by Preserve authorization and NPS policies cited above. Adherence to State hunting and trapping regulations within BTNP minimizes confusion and conflict, and it simplifies enforcement. State laws permit hunting of white-tailed deer, rabbits, feral hogs, squirrels, and waterfowl and trapping of raccoons, possums, mink, fox, and nutria. TPWD information suggests that hunting use is increasing only slowly. There is a strong hunting tradition in Texas, but it has been offset by changing patterns of culture/leisure activities, so a dramatic increase in hunter pressure is not expected (Callaway 1996).

Fewer than 20 trapping permits are issued annually. In the 1990-96 period, about 2,300 hunter permits were issued each year; the policy is to set a limit of 3,200 permits. Permits are issued on a first-come, first-served basis at scheduled sites and times. Hunters and trappers are asked to return game harvest cards. Though the initial return rate was low, the number of returns increased when future permits were made conditional on return of harvest cards. The permit process is important in promoting hunter safety and adherence to regulations. However, it makes heavy seasonal demands on personnel (Callaway 1994).

Visitor safety, especially for boaters, is dealt with by the prohibition of hunting within 500 feet of roads and watercourses and the prohibition of loaded guns in boats. During hunting season, the need to patrol hunting areas to promote safety and enforce regulations seriously limits the ability of Rangers to respond to boater emergencies in a timely fashion. While there have not yet been any incidents in which inability of Rangers to respond to an emergency has been an issue, there is a potential conflict between the hunting program and visitor protection in river corridor units.

TPWD wildlife population monitoring programs (Harcombe et al 1996) suggest that game populations in BTNP and surrounding areas are sustainable at current levels of hunting and trapping pressure with current regulations. However, field observations by enforcement and resource management personnel suggest that illegal taking of game has reduced populations of both game and non-game species to an extent that detracts from public enjoyment. An implication of these observations is that additional information on levels of animal populations may be necessary.

There are no specific wildlife protection issues in the Neches Bottom or Beaumont Units that are known to require additional restrictions to hunting or trapping that are more restrictive than the general hunting and trapping regulations. Instead, the major issue reported by field personnel is related to the illegal (rather than permitted) taking of game without regard to season, bag limit, or mode of taking. These practices appear to be a cultural norm within some communities of the Big Thicket. (Abernathy 1967 provides examples of the colorful culture of the Big Thicket region.)

The Neches Bottom Unit presents specific law enforcement difficulties because of its inaccessibility. First, limited public road access makes it difficult to patrol except by boat. Second, low visibility of boundary markers makes it hard for hunters to know exactly when they are in the unit. An additional issue is that Federal laws regarding the transport of guns in boats are more restrictive than State laws. (36 CFR 2.4(b) prohibits carrying a loaded gun in a motor vehicle or vessel unless the vessel is being used as a shooting platform in accordance with federal law; Texas law does not prohibit carrying loaded guns in boats.) Finally, there is a problem with hunters using the river as an access route for unauthorized hunting on private lands that abut the Neches Corridor units.

Possible general guidelines. With respect to hunting and trapping in the Water Corridor Units, the following alternatives are identified:

a. Allow hunting in the Neches Bottom and Beaumont Units in accordance with existing hunting regulations.
b. Allow hunting in the Neches Bottom but restrict dates (beyond general restrictions) to minimize visitor protection problems and enforcement costs.
c. Declare the Neches Bottom closed to hunting for reasons of visitor protection and

enforcement difficulties.

Recommended general guideline. Hunting and trapping should be allowed in the Neches Bottom and Beaumont Unit in accordance with established Hunting Policy, with any additional restrictions necessary to sustain wildlife populations, visitor safety, and a strong land/water and resource protection ethic.

Recommended management actions.

- Curtail illegal taking of game through field patrols and contact with adjacent landowners, hunting clubs, and timber company hunting lease administrators.

- Reduce problems caused by inconsistencies between Federal and State firearm laws. This can be accomplished in part by seeking the assistance of TPWD in advising hunters about compliance with Federal laws while hunting on Federal preserves and refuges.

- Promote safety of hunters in the Neches Bottom and Beaumont Units and visitors on waterways or neighboring lands by continuing to provide educational materials along with the hunter registration packet that promote safe handling of fire arms, good hunting etiquette, and a strong conservation ethic. Maps that clearly delineate areas open to hunting must be provided to hunters and other visitors, as well. Ensure that adequate boundary and other orientation markings are established and maintained within the Neches Bottom Unit.

- Establish a program for monitoring populations and harvest levels for game species within the preserve. Redesign of the hunter and trapper harvest reports to include more information on size, weight, and condition of harvested game can contribute valuable ancillary information. In addition to its value for resource protection, it provides a scientifically credible basis for determining the number of permits to issue and areas open to hunting and trapping.

3.2 Fishing

Fishing is recognized as a legitimate park use under certain circumstances. NPS Management Policies (NPS 1988a, 8:4) provide that recreational fishing will be allowed in parks when authorized, or not specifically prohibited, by federal law. Fishing is to be conducted in accordance with federal laws, treaties, and applicable laws of the state in which the park is located. The National Park Service may restrict fishing activities to achieve objectives of the park's resource management plan. Commercial fishing is allowed "only where specifically authorized by federal law or treaty right" (8:4).

Fishing may be restricted to meet a number of objectives as part of a fisheries management program (4:8). For example, restrictions may be put in place to protect endandered species; for scientific study, interpretation, or other public benefits; for species population management; to protect the integrity of aquatic areas in natural zones; or to maintain fish as a food source for native wildlife species. In general, stocking programs are limited to native species (4:8).

36 CFR Sec. 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). 36 CFR 2.3(c) provides that the superintendent will consult with appropriate State agencies before invoking the authority given in section 1.5 except in cases of emergency or areas of exclusive federal jurisdiction. 36 CFR 2.3(a) provides that fishing will occur in accordance with state law, and "nonconflicting State laws are adopted as a part of these regulations".

Sec. 2.3.(d) sets out a list of prohibited fishing practices, including fishing in locations that might conflict with other public uses such as swimming and boating (Sec. 2.3.(d)(8)). Section 2.4 proscribes the use of certain weapons, traps and nets, and section 2.5 describes the conditions under which the taking of research specimens is allowed.

Big Thicket National Preserve Establishment Act of 1974 [PL93-439, Sec. 4(c)] directs that fishing be permitted. The intent was to allow (protect) the continuation of traditional uses of wild lands of the Big Thicket. These activities may be restricted to certain areas or times for reasons of public safety, administration, resource protection, or public use and enjoyment. Except in emergencies, fishing restrictions "shall be put into effect only after consultation with the appropriate State agency." For BTNP, the appropriate state agency is the Texas Parks and Wildlife Department.

The BTNP General Management Plan (NPS 1980, p.47) recognizes the requirements of PL93-439 and directs that the NPS "will establish an action plan for hunting, fishing, and trapping management" to provide for resource protection and visitor safety. The Plan states (p. 49) that the hunting, fishing, and trapping management action plan will determine the intensity and yearly distribution of hunters and fishermen.

The BTNP Final Draft Statement for Management (NPS 1995a, pp. 11-12) states that fishing in the Neches River and Little Pine Island Bayou is under the jurisdiction of the Texas Parks and Wildlife Department, while the NPS has jurisdiction in "the numerous streams, creeks, oxbows, and sloughs in the majority of the Preserve units." (NPS exercises concurrent jurisdiction with TPWD on the navigable streams.) A lack of data to determine the impact of recreational or commercial fishing is noted. It states that a fisheries management plan is being prepared.

BTNP Standard Operating Procedure 94-7141-02 (Superintendent's Orders) (NPS 1994a) does not mention any restrictions pertaining to fishing beyond those set by state law.

Background. Public fishing is allowed in accordance with State and federal law, and enforcement is shared with the Texas Parks and Wildlife Department (NPS 1988b; NPS 1975). State regulations governing fishing are published annually by TPWD. There are some differences in practices permitted by TPWD and those allowed under federal law (NPS 1995a, pp. 11-12). These differences have the potential to generate unnecessary confusion. Adherence to a single set of fishing regulations within all areas of BTNP would minimize confusion and conflict, and would simplify enforcement.

Fishing is probably the source of most visitor hours spent in the Preserve (Callaway 1996). State licenses for recreational fishing are not place-specific; therefore, information on fishing use of the Preserve is not obtainable from administrative records. Survey data are limited.

TPWD monitoring programs provide only limited information about gamefish populations in the Neches River (Harcombe et al 1996). Additional catch data would be desirable, particularly with regard to the impacts of practices permitted by State regulations that are prohibited under federal regulations (e.g., commercial fishing and the use of nets).

Ranger monitoring of fishing practice and enforcement of regulations is done infrequently because of limited staff.

TPWD recently reintroduced the endangered Paddlefish into the Upper and Lower Neches River (Pitman 1991, 1992).

There is a potential for user conflict between fishers and hunters in the units near the water corridors. Visitor safety during hunting seasons, especially for boaters, is dealt with by the prohibition of hunting within 500 feet of roads and watercourses and the prohibition of loaded guns in boats.

Possible alternatives. With respect to fishing in the Water Corridor Units, the following alternatives are identified:

a. Allow fishing in accordance with existing regulations.
b. Promulgate new regulations through TPWD to prohibit commercial activity and use of nets.

Recommended general guideline. Fishing should be allowed in the river corridor units in accordance with established state law, with any additional restrictions necessary to sustain fish populations, visitor safety, and a strong land/water and resource protection ethic.

Recommended management actions.

- Promote adherence to applicable fishing laws through casual field interviews initiated by Rangers on routine patrol.

- Reduce problems caused by inconsistencies between Federal and State fishing laws. This can be accomplished in part by seeking the assistance of TPWD in advising fishermen about compliance with Federal laws while fishing in Federal preserves and refuges. A complete solution will involve switching to a single set of fishing laws through legislative action at the Federal level.

- Promote safety of fishers by continuing to provide educational materials and signage.

- Acquire the fish population data necessary to assure that fish resources are adequately protected. This may be accomplished through transfer from other agencies, contract research, or staff monitoring of populations. Fisher harvest reports based on Ranger interviews, which include information on size, weight, and condition of harvested fish, as well as level of effort and mode of fishing., can provide some information for this purpose.

- Prepare fishing action plan per the directive of the General Management Plan

3.3 Boating

Provision in the NPS organic act for public use and enjoyment of park facilities can be construed as permissive of recreational boating and associated activities. NPS Management Policies (NPS 1988a, 8:2) specifically recognize boating as allowed in parks when authorized, or not specifically prohibited, by federal law. Boating is to be conducted in accordance with federal laws, treaties, and applicable laws of the state in which the park is located. The National Park Service may restrict boating activities to achieve objectives of the park's resource management plan. When boating is allowed, the NPS will provide facilities such as boat ramps and sewage pump-out stations as appropriate for "safe visitor enjoyment of water recreational resources and to protect natural resources" (9:14). Navigation aids are to be planned in collaboration with the U.S. Coast Guard and meet Coast Guard standards, except that NPS and USCG can jointly modify those standards to meet specific park needs (9:11).

NPS Management Policies (8:3) state that a "river management plan will be developed for each park having significant levels of river use, or the potential for such use." River management plans are intended to prevent unacceptable impacts on aquatic resources. Each plan is required to address the disposal of refuse and human waste.

36 CFR Sec. 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). 36 CFR 2.3(c) provides that the superintendent will consult with appropriate State agencies before invoking the authority given in section 1.5, except in cases of emergency or areas of exclusive federal jurisdiction. 36 CFR 3.1 provides that boating and water use activities are governed by Title 14 USC, 33 CFR, 46 CFR and 49 CFR as well as NPS regulations and those of the State; the superintendent is authorized to act as "captain of the port" under federal laws.

36 CFR 3.3 provides that the superintendent may require a permit for use of a boat within a park area. BTNP has not exercised this authority. Authorized park personnel also are allowed to inspect boats within the park for compliance with safety regulations (Sec. 3.5).

36 CFR 3.6 provides a list of prohibited operations, including:

(a) operating a vessel recklessly or negligently so as to endanger persons or property;
(b) operating a vessel under the influence of alcohol or a controlled substance;
(c) failing to observe restrictions established by a regulatory marker;
(d) and (e) operating a vessel in excess of 5 mph or creating a wake in designated areas of within 100 feet of swimmers, or within 500 feet of a swimming beach;
(f) allowing a person to ride on the gunwales, transom, or decking of a motorboat operating in excess of 5 mph except in special circumstances;
(g) attaching a vessel to or interefering with a marker, buoy, or other navigational aid;
(h) using trailers to launch or recover vessels, except at designated launching sites;
(i) launching a motor boat at other than designated sites;
(j) operating a motor boat on waters not directly ccessible by road;
(k) launching or operating airboats; or

(l) operating a vessel in excess of designated size, length or width restrictions.

Sec. 3.7 establishes noise limits for boats. Operating a vessel at noise levels greater than 82 decibels measured at a distance of 82 feet (25 meters) from the vessel is prohibited and testing procedures are established.

Big Thicket National Preserve Establishment Act of 1974 [PL93-439] cites the "preservation, conservation, and protection of the natural, scenic, and recreational values of a significant portion of the Big Thicket area in the State of Texas" and "the enhancement and public enjoyment thereof," as the reason for the preserve's creation. Sec. 4(b) provides that "in the interest of maintaining ecological integrity of the preserve" construction of facilities and the use of motorized water vehicles (among other uses) will be limited and controlled.

The BTNP General Management Plan (NPS 1980, pp.16-18) establishes recreation zones within which uses such as boating are appropriate. Continued boating use of the Neches River and Little Pine Island Bayou downstream of the U.S. 69 bridge was anticipated, and upgrading of existing access points and construction of new sites was planned (p. 49). All streams (other than the Neches River and Little Pine Island Bayou downstream of U.S. 69--p. 16), including the Menard Creek Corridor unit and the Little Pine Island Bayou unit upstream of the U.S. 69 bridge are planned to have "small water access points for hand-launched boats, and use of motors will not exceed 5 hp." (p. 49). Table 4 of the Plan (p. 53 et seq.) lists Interpretive Media planned in conjunction with boat launch and other sites. The Management Plan provides that no hiking trails will be developed along water corridors (p. 49).

The General Management Plan reiterates the limits on recreational development and communicates the philosophy that most support facilities will be located outside the preserve. There is an implied preference for private development and ownership of these facilities.

The BTNP Final Draft Statement for Management (NPS 1995a, pp. 9-10) mentions boating in a list of current recreational uses of waters of the Preserve. It also notes that increasing boat use has created a demand for boating related concessions. No boat ramps are discussed in the facilities maintenance section (pp. 24-27). Two sites are noted in the background information on facilities (p. 41, p. 44): a ramp at McQueen's Landing on the east side of the Neches River below Dam B, and a ramp at the confluence of the Neches River and Pine Island Bayou.

BTNP Standard Operating Procedure 94-7141-02 (Superintendent's Orders) (NPS 1994a) does not mention any restrictions pertaining to boating, other than Sec. 3.20(a) which provides that water skiing is allowed on the Neches River and Pine Island Bayou. Boating is managed under general NPS regulations and those of the State of Texas.

State boat registration is enforced by Rangers under a general MOU with the Texas Parks and Wildlife Department covering all NPS areas in Texas and initially signed June 26, 1975, and renewed April 4, 1987 (NPS 1975, 1995, pp. 37-38).

Background. River corridor units fall into two distinct types, those associated with the Neches River (Upper Neches River Corridor Unit, Neches Bottom and Jack Gore Baygall Unit, Lower Neches Neches River Corridor Unit, Beaumont Unit, and the Little Pine Island Bayou Corridor Unit below the U.S. 69 bridge) and those associated with its tributaries (Pine Island Bayou/Little Pine Island Bayou above the U.S. 69 bridge and Village Creek) and Menard Creek, a tributary of the Trinity River. Because these two type of streams are so different, they will be considered separately as necessary in this and following boating subsections.

Public use is allowed in the water corridors of the Preserve, and boating is a major use of the Preserve, in spite of a limited number of boat ramps and access points to the waterways. Most of the boat ramps are administered by entities other than the NPS (Texas Department of Transportation, Hardin County, and private individuals). (See Table 4 and Figure 3.) Partly as a result of this, the level of use of these facilities is uncertain (Callaway 1996).

Maintenance personnel visit the two BTNP ramps every month, and perform close visual inspections about once every three months. If possible, they will observe boat launches and converse with boaters to determine if any maintenance actions are required. According to maintenance observations, the Four Oaks-Confluence boat ramp, which was built by NPS, is heavily used. The McQueen's Landing boat ramp, which is very old and accessed by a long dirt road, is less heavily used. The ramps do not require much actual repair or maintenance. Ranger monitoring is constrained by staff levels. Because of the time required to cover distances between the launch sites, patrol of launch areas is extremely limited.

There is a potential for conflict between motor-boaters (and jet skis) and others (e.g., fishers, swimmers, non-motor-boaters). This can be mitigated by establishment of zones which segregate incompatible activities or minimize incompatibilities through restrictions on boats (horsephower limits), boat operation (such as the no-wake zone at Lakeview), or other activities. Up to 1996, few complaints have been logged in the incident report files, and, except for the Lakeview area, no safety incidents have been reported. Nevertheless, it may be prudent to delineate additional zones before problems arise. It is also desirable to put appropriate mechanisms in place to allow monitoring of public activity and early detection of conflicts that may require delineation of river recreation zones.

Boating also poses potential threats to resources. Wakes can exacerbate bank erosion. Some wake erosion has been noted at Pine Island Bayou, Cook's Lake and along the Neches River (Personal communication with R. Appling, BTNP, NPS, 12 April 1996). Deposition of human feces on sandbars and into the water can potentially create contamination problems. Picnicking on beaches accessible only by boat can result in deposition of trash that is difficult for NPS to collect. Sand bars are visited infrequently by maintenance personnel for cleanup, particularly in the winter season (Personal communication with Ray Martinez, BTNP, NPS). While all these potentially may have resource impacts, they are mostly nuisances or disamenities at current levels of river use. To prevent resource issues from developing, and also to maintain the amenity value of clean waterways and sandbars, regulations need to be posted and widely communicated and sanitary facilities need to be provided at key locations to promote appropriate disposal of trash and human wastes.

Table 4: List of Boat Ramps and water access points

Figure 3. Map of boat ramps

There is a potential safety issue related to existence of snags, abandoned oil wells and pipelines. Several structures were noted in field observations (Callaway et al 1993). Lighted warning makers have been suggested as one safety feature. Maps and/or warnings could be included as part of general brochures on boating in BTNP.

Public use of the water corridors is influenced by canoe liveries operating out of Houston, Beaumont, Kountze, and Silsbee (Callaway 1995). These existing liveries promote public use of the Preserve; at the same time they limit use, since the number of canoes available is limited. (Given the small number of BTNP staff available for monitoring use, a rough estimate of canoe pressure could be gained by having volunteers count cars/boats on Village Creek at Highways 327, 418 or 69.) A foreseeable problem is parking at put in/take out locations -- some degradation of habitat has been observed around the bridges over Village Creek in the proposed Village Creek Corridor. Limited parking space also serves as a practical restriction on the number of boats and canoes in the corridors. This is mitigated in part by use of the Village Creek State Park lot, which requires payment of a $2 state park entry fee (Personal communication with Nelda Overstreet, Timber Ridge Tours). BTNP could limit use by requiring permits for liveries, tour operators, or guides who run fee operations within the preserve. Permitting could also serve as a vehicle to assure that livery operators have appropriate liability coverage and pay attention to regulations that promote visitor safety and resource protection.

Possible alternatives. With respect to boating in the Water Corridor Units, the following alternatives are identified:

1) Actively discourage public boating use through promulgation of restrictive policies.

2) Actively encourage public boating use through construction of additional boat ramps and other facilities at access points where appropriate and consistent with use zones of the corridors.

3) Maintain the status quo.

Recommended general guideline. The general policy of BTNP with respect to boating use of Water Corridor Units should be to promulgate such policies and regulations that promote safe, enjoyable boating experiences consistent with protection of resources and of quality of the outdoor experience.

Recommended management actions.

- Promote adherence to boat registration and boating safety laws through field interviews initiated by Rangers on a routine/casual basis, as well as routine patrols at strategic places and times.

- Initiate monitoring programs to track visitor satisfaction and resource quality to provided a basis for identifying the recreational carrying capacity of the corridors.

- Produce and distribute additional information brochures identifying opportunities for safe and resource-compatible recreational use. Consider distribution to targeted audiences such as those found at commercial outlets catering to boaters.

- Acquire the data necessary to assure that biotic resources are not impaired by boating uses. This may be accomplished through transfer from other agencies, contract research, or staff monitoring of populations and bank conditions.

- Address the use of boats for hunting, trapping and fishing activities in the hunting, trapping and fishing action plan to be prepared as directed by the General Management Plan.

- Maintain NPS boat ramps in safe condition with suitable facilities for trash and human waste disposal.

3.4 Swimming and Picnicking

Authority. The 1916 NPS organic act (16 USC 1) provision for public use and enjoyment can be construed as permissive of swimming and picknicking activities in the water corridors.

NPS Management Policies (NPS, 1988, 8:2) specifically recognize swimming and picnicking as recreational acitivities allowed in parks when authorized, or not specifically prohibited, by federal law. Recreational activities are to be conducted in accordance with federal laws, treaties, and applicable laws of the state in which the park is located and the National Park Service may restrict recreational activities to achieve objectives of the park's resource management plan.

NPS Management Policies (8:3) state that a "river management plan will be developed for each park having significant levels of river use, or the potential for such use." River management plans are intended to prevent unacceptable impacts on aquatic resources. Each plan is required to address the disposal of refuse and human waste.

36 CFR Sec. 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). 36 CFR 3.1 provides that water use activities are governed by Title 14 USC, 33 CFR, 46 CFR and 49 CFR as well as NPS regulations and those of the State; the superintendent is authorized to act as "captain of the port" under federal laws.

36 CFR 3.6 provides a list of prohibited boating operations that includes: (d) and (e) operating a vessel in excess of 5 mph or creating a wake in designated areas of within 100 feet of swimmers, or within 500 feet of a swimming beach.

Sec. 2.11 provides that picnicking is allowed, except in designated areas closed under Sec. 1.5. The superintendent may establish conditions for picnicking and the violation of those conditions in prohibited.

Sec. 3.21 details prohibited activities associated with swimming. The superintendent may restrict activities at designated swimming beaches (Sec. 3.21 (b)).

Big Thicket National Preserve Establishment Act of 1974 [PL93-439] cites the "preservation, conservation, and protection of the natural, scenic, and recreational values of a significant portion of the Big Thicket area in the State of Texas" and "the enhancement and public enjoyment thereof," as the reason for the preserve's creation. Sec. 4(b) provides that "in the interest of maintaining ecological integrity of the preserve" construction of facilities and the use of motorized water vehicles (among other uses) will be limited and controlled.

The BTNP General Management Plan (NPS 1980, pp.16-18) establishes recreation zones within which uses such as swimming are appropriate. Lakeview Sandbar (also called Lakeview Beach) in the Beaumont Unit is the only major swimming site in the Preserve. Two smaller sites on Menard Creek (Holly Grove and Whoop-N-Holler) have traditionally been used for swimming and baptisms. Picnicking/day use sites have been identified at several locations. The Plan provides that no linear hiking trails will be developed along water corridors (p. 49).

The General Management Plan reiterates the limits on recreational development and communicates the philosophy that as many support facilities will be located outside the preserve. There is an implied preference for private development and ownership of these facilities.

The BTNP Final Draft Statement for Management (NPS 1995a, pp. 9-10) mentions swimming in a list of current recreational uses of waters of the Preserve. It also notes that while visitor use is increasing, visitor protection efforts are hampered by underfunding of law enforcement ranger activity (p. 22).

BTNP Standard Operating Procedure 94-7141-02 (Superintendent's Orders) (NPS 1994a) establishes visiting hours for Lakeview Sandbar Day Use Area in the Beaumont Unit (p. 5) and Edgewater Day Use Area on Pine Island Bayou (p. 6) . These areas are closed to public use during "the hours of darkness", defined as 1/2 hour after sunset until 1/2 hour before sunrise and signs are posted with that information (see Table 5). Addtional day use areas in the water corridors (see Table 6) are designated for closing from 11 p.m. until 6:00 a.m. daily

(p. 7). Alcoholic beverages are prohibited from all of the designated recreational areas (p. 16).

Background. Public use is allowed in the water corridors of the Preserve, and swimming and picnicking are traditional uses of the area. Information on the current level of use of the recreational areas is inadequate to determine carrying capacity of the river corridors (Callaway 1996).

Table 5. Recreational use areas in the water corridors closed during hours of darkness: 1/2 hour after sunset until 1/2 hour before sunrise

---

- Beaumont Unit
  - Lakeview Sandbar (Lakeview Beach) swimming area, west of Booth's Bayou (part of Tract 194-01)

- Pine Island Bayou/Little Pine Island Bayou Corridor Unit
  - Edgewater Day Use Area (part of Tract 189-19)

Table 6. Recreational use areas in the water corridors open for public use: 6:00 a.m. to 11:00 p.m.; closed 11:00 p.m. to 6:00 a.m.

- Neches Bottom/Jack Gore Baygall Unit
  - Franklin Lake recreational use area
  - Timber Slough Road recreational use area, at Neches River

- Lower Neches River Corridor Unit
  - Highway 96 recreational use area, Evadale Bridge

- Beaumont Unit
  - Confluence recreational use and boat ramp parking area, Four Oaks Ranch Road
  - Four Oaks Ranch Road recreational use and parking area, Four Oaks Ranch Road

Pine Island Bayou/Little Pine Island Bayou Corridor Unit
    Cook's Lake Road recreational use and parking area

Menard Creek Corridor Unit
    Holly Grove recreational use and parking area
    Whoop-N-Holler recreational use area

Ranger monitoring is constrained by staff levels. Because of the time required to cover distances between the recreational sites, patrol of recreational areas is extremely limited.

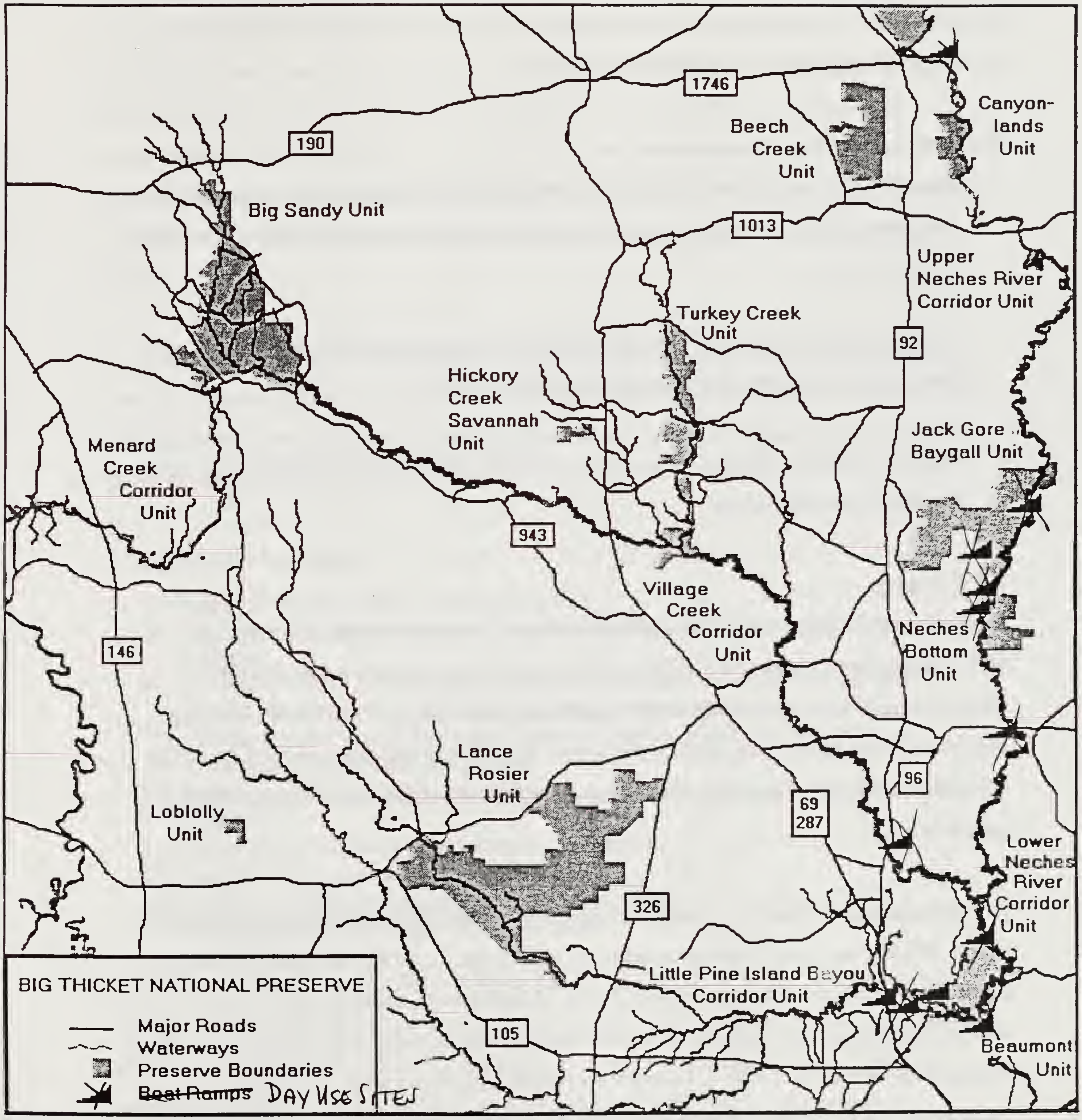
There is a potential for conflict between recreational users of the Preserve and neighbors near the recreational areas. For this reason, most of the areas are designated for day use. (See Tables 5 and 6 and Figure 4.) There is also a potential for conflict among users of the Preserve's water resources: motor-boaters (and jet skis) and others (e.g., fishers, swimmers, non-motor-boaters). This can be mitigated by establishment of zones which segregate incompatible uses or minimize incompatibilities through restrictions on boats (horsepower limits) or boat operation (such as the no-wake zone at Lakeview). To 1996, few complaints or safety incidents have been logged in the incident report files, and those which have been filed occur mostly at Lakeview. It may be prudent to put appropriate mechanisms in place to allow monitoring of public activities and early detection of conflicts that may require delineation of river recreation zones.

Swimming and picnicking can be a threat to resources. Human and other waste must be disposed of properly. Picnicking on beaches accessible only by boat can result in trash deposition. While all these potentially may have resource impacts, they are mostly nuisances or disamenities at current levels of river use. So as to prevent resource issues from developing, and also to maintain the amenity value of clean waterways and sandbars, regulations need to be posted and sanitary facilities need to be provided to promote appropriate disposal of trash and human wastes.

Possible alternatives. With respect to swimming and picnicking in the Water Corridor Units, the following alternatives are identified:

- Actively discourage public use through promulgation of restrictive policies.
- Actively encourage public use through construction of additional facilities as currently designated day use sites and designate additional sites.
- Maintain the status quo.

FIGURE 6. BTNP DAY USE SITES


1746
190
Beech Creek Unit
Canyonlands Unit
Big Sandy Unit
1013
Upper Neches River Corridor Unit
Turkey Creek Unit
92
Hickory Creek Savannah Unit
Menard Creek Corridor Unit
Jack Gore Baygall Unit
943
Village Creek Corridor Unit
Neches Bottom Unit
146
Lance Rosier Unit
96
Loblolly Unit
69
287
Lower Neches River Corridor Unit
326
Little Pine Island Bayou Corridor Unit
105
Beaumont Unit
BIG THICKET NATIONAL PRESERVE
Major Roads
Waterways
Preserve Boundaries
~~Boat Ramps~~ DAY USE SITES

Recommended general guideline. The general policy of BTNP with respect to swimming and picnicking use of the Water Corridor Units should be to promulgate such policies and regulations that promote safe, enjoyable recreational experiences consistent with protection of resources and of quality of the outdoor experience.

Recommended management actions.

- Promote adherence to Preserve visitor use and safety regulations through casual field interviews initiated by Rangers on routine patrol, as well as by regular patrols at strategic places and times.

- Initiate monitoring programs to track visitor satisfaction and resource quality, so as to identify tthe recreational carrying capacity of the corridors.

- Produce additional information brochures identifying opportunities for safe and resource-compatible recreational use.

3.5 Camping

Authority. Camping is recognized as a legitimate park use under certain circumstances. NPS Management Policies (NPS 1988a, 8:2) provide that recreational camping will be allowed in parks when authorized, or not specifically prohibited, by federal law. Camping may be restricted by the National Park Service to "protect park resources, provide for public enjoyment, promote public safety, and minimize conflicts with other visitor activities and park uses" (8:2).

NPS Management Policies (8:3) define "backcountry" as primitive, undeveloped portions of parks. Within these areas the number and types of facilities, including sanitation facilities, to support visitor use are to be very limited (8:3,4). A backcountry management plan must incorporate management strategies to prevent unacceptable impacts of visitor use (8:3). The Policies provide that NPS will: (1) identify acceptable limits of impacts; (2) monitor backcountry use levels and resource conditions; and (3) take prompt corrective action when unacceptable impacts occur (8:3). Backcountry campsites may be permitted within acceptable limits of use (9:13).

In some circumstances, NPS Management Policies provide for "boaters' campgrounds in parks with waters used for recreational boating" (9:13). These campgrounds are to be considered only after considering: the type of water body; the availability and resiliency of potential campsites; tlhe feasibility of providing and maintaining docking, beaching, mooring, camping, and sanitary facilities; and potential impacts on park natural and cultural resources (9:13).

36 CFR Sec. 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). Sec. 2.10(a) specifically provides that the superintendent may require permits, designate sites or areas, and establish conditions for camping.

Prohibited acitivities include:

(1) digging or leveling the ground at a campsite;
(2) leaving camping equipment, site alterations, or refuse after departing from the campsite;
(3) camping within 25 feet of a water hydrant or main road, or within 100 feet of a flowing stream, river or body of water, except as designated;
(4) creating or sustaining unreasonable noise between the 10:00 p.m. and 6:00 a.m.
(5) installing permanent camping facilities;
(6) displaying wildlife carcasses or other remains, except as provided in Sec. 2.2, wildlife protection;
(7) connecting to a utility system, except as designated;
(8) failing to obtain a permit, where required;
(9) violating conditions established by the superintendent;
(10) camping outside of designated sites or areas.

Big Thicket National Preserve Establishment Act of 1974 [PL93-439, Sec. 1(a)] states that one of the purposes of the Preserve is to protect natural, scenic, and recreational values of the area and to provide for enhancement and public enjoyment of the Big Thicket. Public use may be restricted to certain areas or times for reasons of human safety, administration, resource protection, or public use and enjoyment.

The BTNP General Management Plan (NPS 1980, p.50) states that "general development for camping is not planned". Backcountry primitive camping is allowed in designated units of the Preserve -- within the water corridors, only the Neches Bottom/Jack Gore Baygall Unit was named as a backcountry camping area. A primitive camping area is identified within that area; a self-contained toilet is the only facility envisioned (p. 80).

The BTNP Final Draft Statement for Management (NPS 1995a) does not mention camping in its discussion of public use of the Preserve.

BTNP Standard Operating Procedure 94-7141-02 (Superintendent's Orders) (NPS 1994a) Sec. 2.1 pertains to camping. Areas open to backcountry camping include, among others, the Beaumont Unit, Neches Bottom/Jack Gore Baygall Unit; sandbars along the Neches River within the Preserve boundary; and islands within the Neches River (p. 12). Camping is prohibited on three sandbars which are designated for more intensive day use: Lakeview sandbar, the sandbar in Orange County directly across from Lakeview, and the sandbar located at the eastern end of Timber Slough Road in Hardin County (p. 13). During hunting season (October 1 through January 15) all of the Neches Bottom/Jack Gore Baygall Unit is closed to camping; portions of the Beaumont Unit and all of the Neches River units are open to camping year-round (p. 12).

Permits are required in advance for backcountry camping (p. 13). Permits, with accompanying conditions for use, are issued in person only to a member of the party, or to the holder of a Commercial Use License expressly authorizing this activity (p. 13).

Background. Only backcountry camping is allowed within the BTNP. This is consistent with the purposes of establishing the park as a natural preserve. The General Plan calls for minimal development within the park (p.50). Through participation with state and local groups dealing with tourism and recreation, such as the Southeast Texas Partnership for Tourism, Recreation and the Environment, the NPS has encouraged the development of supporting services outside the boundaries of the Preserve (Callaway 1994, 1995).

Within the water corridors, backcountry camping on the banks and islands of the Neches River has been permitted as a continuance of local custom. No developed facilities are provided at these locations. The current density of campers does not appear to pose a problem, although litter can create eyesores.

There is a potential for user conflict between campers and hunters in the units near the water corridors. Visitor safety during hunting seasons, especially for campers, is dealt with by the prohibition of hunting within 500 feet of roads and watercourses, the prohibition of loaded guns in boats, and the prohibition of backcountry camping in the Neches Bottom/Jack Gore Baygall Unit during hunting season.

Although there is a body of literature indicating that visitor density affects the quality of backcountry visits (see for example, NPS 1989), no quantitative data exist to establish a density of camping use of the banks and islands of the Neches River, nor have staff resources allowed for surveys of visitor satisfaction. Field observation by rangers and research personnel indicates that densities are low at present and are not likely in the near future to exceed a level which would impact the quality of visitor experience or resource protection.

Possible alternatives. With respect to backcountry camping in the Water Corridor Units, the following alternatives are identified:

a. Allow backcountry camping in accordance with existing regulations.

b. Further restrict numbers of backcountry camping permits issued.

c. Encourage backcountry camping by increasing parking and other facilities that give access to the backcountry.

Recommended general guidelines. Backcountry camping shall be allowed in the river corridor units in accordance with established policy, with any additional restrictions as necessary to protect water quality and bank stability, visitor safety, and a strong land/water and resource protection ethic.

Recommended management actions.

- Promote adherence to applicable backcountry camping regulations through casual field interviews initiated by Rangers on routine patrols.

- Promote safety of campers by continuing to provide educational materials and signage, particularly at river access points.

- Acquire the data necessary to assure that resources in visitor use areas are adequately protected. The necessary information can be acquired through (1) annual review of records and incident reports; (2) annual visual assessment of trash loads and camper impact on sandbar vegetation and bank conditions; and (3) water quality monitoring at sites near camping areas.

- Adopt formal name for the two unnamed sandbars on which backcountry camping is prohibited to better communicate with the public.

- Review and update the Backcountry Camping Management Plan periodically -- at least once every five years.

3.6 Houseboats in the BTNP

Background. Houseboats are a special case of boating use of the Preserve. Houseboats (Fed. Reg. Vol. 61, P. 28530, June 5, 1996) have been permanently moored on the Neches River and its tributaries within Preserve boundaries, relatively unregulated, since before creation of the Preserve. The majority of houseboat owners have been identified by BTNP staff as local residents. Reportedly, the number of houseboats has increased in recent years; however, systematically collected data to document that trend are not available.

Until recently, specific regulations or policies to limit or control houseboat activities in the Preserve did not exist. However, boating regulations such as those pertaining to sanitation and refuse, fire extinguishers, and personal flotation devices on board also apply to houseboats. It has been proposed that all houseboats within the Preserve be required to obtain a permit and post a decal visible to Preserve personnel from the water (NPS 1994a). In 1995, regulations for houseboats in the Preserve were proposed in order to strengthen the Preserve staff's ability to manage impacts of houseboats. NEPA procedures for analysis, review and comment were initiated and proposed regulations were published in the June 5, 1996 issue of the Federal Register (Vol. 61, p. 28530).

Impacts to water corridor resources. The presence of houseboats threatens habitat resources in several ways. Mooring and access practices result in damage to surrounding vegetation and in bank erosion. Water pollution (discharge of sewage, animal and fish remains, etc.), and poaching of fish and game have been reported. Houseboats are a source of noise pollution in backcountry areas and many are aesthetically displeasing to other Preserve visitors. By permanent or semi-permanent mooring, the houseboats prevent other visitors access to some parts of the Preserve. Houseboats can be a safety hazard to other boaters, and many are unsafe to their occupants. Law enforcement personnel have voiced concerns about the suspected use of houseboats as a platform or vehicle for activities which may include poaching, illegal fishing, illegal drug use and other unlawful activity.

Considerations for NPS research plan. To deal with the problem of houseboats, NPS needs: 1) a field survey to confirm houseboat presence in tributaries to as well as the main channel of the Neches River; and 2) documentation of negative impacts of houseboats (water quality samples; photos of damaged shoreline vegetation; law enforcement incidents reports) to support enforcement activities.

Recommended management actions. Several actions may help the NPS address the houseboat issue:

- Work with TNRCC and LNVA on water quality sampling to determine impacts of houseboats.
- Increase Ranger presence to document impacts of houseboats and discourage unlawful

activities.

- Work with State and Federal law enforcement agencies re possible drug activities.
- Rigorously enforce regulations to control impacts within the Preserve.
- Issue no permits for houseboats not currently located within the Preserve and do not allow replacement of existing houseboats.

3.7 Mineral Extraction and Transport

The Big Thicket area historically has been the scene of oil and gas extraction and transport activities. These historical uses were recognized in the legislation authorizing creation of the Preserve. A number of active or abandoned wells and oil and gas pipelines are present within the Preserve. A total of 32 pipelines have been identified within the Preserve, with an aditional seven within one mile of the boundaries of the BTNP (NPS 1996). Some of these facilities are in or near the water corridors.

Meander of the Neches River has resulted in some abandoned wells originally located on the shore now lying within the bounds of the river. The structures for these wells are now a hazard to boaters. Similarly, pipelines crossing the river may be a boating hazard when they lie near the surface or above water at the river banks. The records floods of October 1994 and the related pipeline spills and fire in the Houston area underscore the danger of pipeline operations in a flood hazard area. Petroleum or petrochemical spills in the waterways could do considerable harm to the area's water quality, aquatic habitat, and aquatic life, as well as negatively impacting public use of the Preserve. Although any of the water corridors could be affected, the Neches River, because of its size, may represent the greatest flood hazard to oil and gas facilities and be most at risk of pipeline spill or fire catastrophe.

Pipeline facilities may also have an impact because of clearing activities or fragmentation of habitat, although this is possibly a greater problem in upland areas than in the water corridors. The effects of fragmentation on floodplain forest habitat were discussed above in section 2.8.

Impacts to water corridor resources. The most likely impact of oil and gas activities to

BTNP habitat resources is the fragmentation of habitat resulting from the construction of structures or land clearing related to operations. Oil and gas activities may impact the habitat resources of the water corridors through impairment of water quality from spills. The risk of fire associated with a spill also represents a threat to species resources.

In addition to potential impacts on habitat and species resources, the presence of pipeline crossings and abandoned wells in the streams is an administrative issue because of human use of the Neches River and a concern for boater safety.

Considerations for NPS research plan. There are no specific additional information needs identified at this time.

Recommended management actions. Several actions could aid the NPS in addressing the potential impacts of oil and gas activities in the Preserve:

- Review BTNP Oil and Gas Management Plan for responsiveness to resource and administrative concerns.
- Work with oil and gas and pipeline companies to develop appropriate operating plans for their activities in the BTNP.
- Work with other agencies and oil and gas industry to develop appropriate standards for pipelines in sensitive or hazardous locales.

3.8 Trash and Waste Disposal

Authority. Provision in the NPS organic act (16 USC 1) for public use and enjoyment can be construed as permitting activities that are necessary for public use in the water corridors. NPS Management Policies (NPS 1988a, 8:3) state that a "river management plan will be developed for each park having significant levels of river use, or the potential for such use." River management plans are intended to prevent unacceptable impacts on aquatic resources. Each plan is required to address the disposal of refuse and human waste.

36 CFR Sec. 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). Sec. 2.11 provides that picnicking is allowed, except in designated areas closed under Sec. 1.5. The superintendent may establish conditions for picnicking and the violation of those conditions is prohibited.

Big Thicket National Preserve Establishment Act of 1974 [PL93-439] cites the "preservation, conservation, and protection of the natural, scenic, and recreational values of a significant portion of the Big Thicket area in the State of Texas" and "the enhancement and public enjoyment thereof," as the reason for the preserve's creation. Sec. 4(b) provides that "in the interest of maintaining ecological integrity of the preserve" construction of facilities and the use of motorized water vehicles (among other uses) will be limited and controlled.

The BTNP General Management Plan (NPS 1980, pp.16-18) establishes recreation zones. The General Management Plan reiterates the limits on recreational development and communicates the philosophy that as many support facilities will be located outside the preserve. There is an implied preference for private development and ownership of these facilities.

Background. Public use is allowed in the water corridors of the Preserve. Human and other waste must be disposed of properly. Picnicking on beaches accessible only by boat can result in trash deposition. While all these potentially may have resource impacts, field reconnaisance (Callaway et al 1993) indicates that they are mostly nuisances or disamenities at current levels of river use. (BTNP maintenance personnel report that collections from the entire Preserve amount to two four-cubic-yard dumpsters filled up each week; Personal communication with Ray Martinez, BTNP, NPS.) To prevent resource issues from developing, and also to maintain the amenity value of clean waterways and sandbars, regulations need to be posted and sanitary facilities need to be provided to promote appropriate disposal of trash and human wastes.

BTNP Maintenance Division staff routinely provide for trash and waste collection. The dispersed nature of the Preserve units would make it difficult to contract privately for these services. Disposal services are contracted when possible.

Possible alternatives. Alternatives for trash and waste disposal are limited.

Recommended general guidelines. The general policy of BTNP with respect to trash and human waste disposal should be to provide only those facilities which are required to support levels of use that will not pose a threat to natural resources. Waste disposal should be carried out in a manner that meets all state and federal environmental regulations. To the extent practicable, facilities for waste disposal should be sought outside the limits of the Preserve.

Recommended management actions.

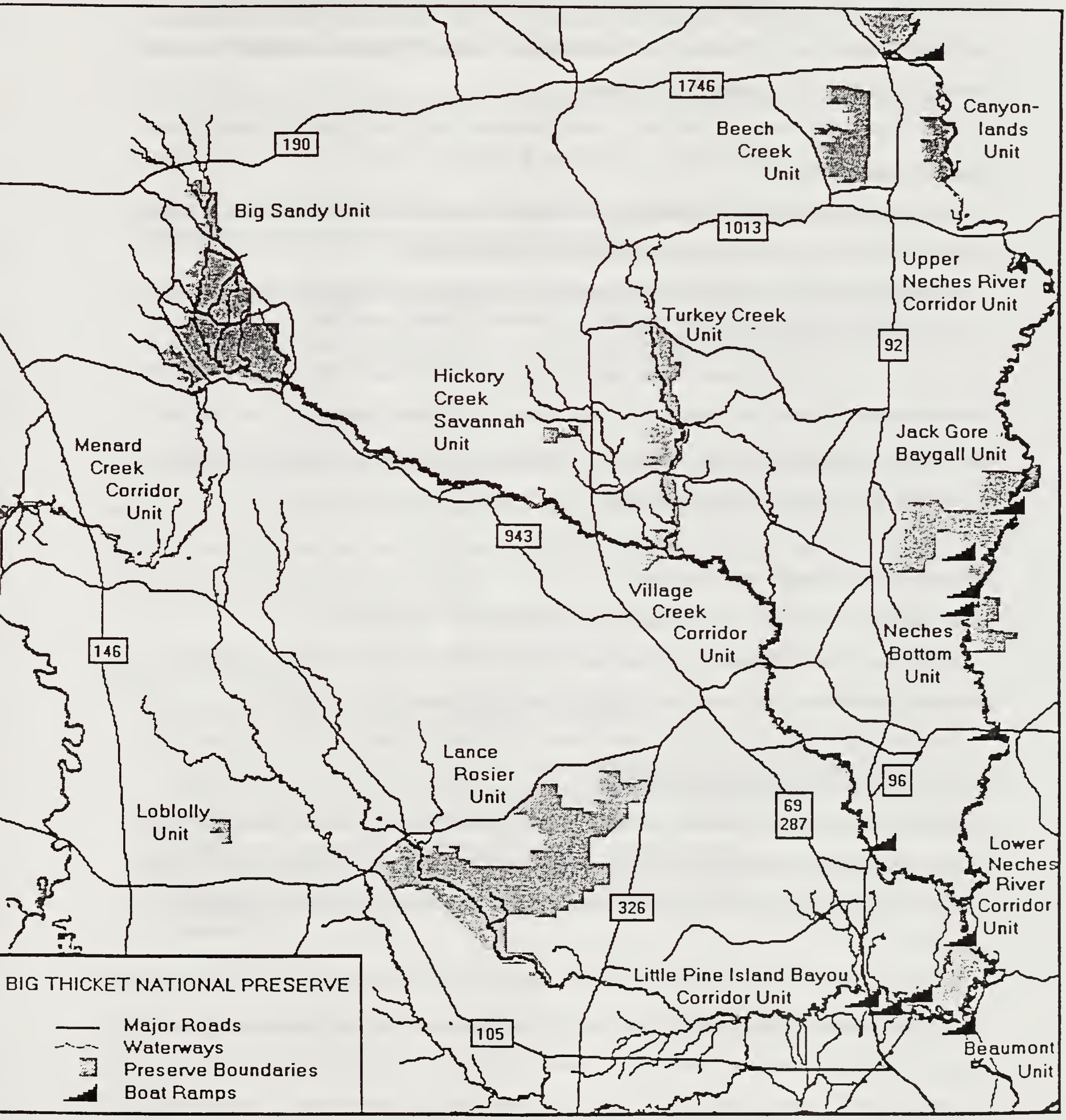
1) Post information promoting appropriate disposal of trash and human wastes.
2) Provide trash and human waste disposal facilities at day use sites.
3) Provide regular cleaning and maintenance of waste disposal facilities.
4) Contract for off-Preserve disposal of wastes whenever possible.
5) Work with other jurisdictions to develop alternative disposal sites.

3.9 River Access

Background. A provision of the General Management Plan dictates that no linear trails will be developed in the water corridors. This, coupled with the small number of streamside sites suitable for development as day use areas included within the Preserve, confines public enjoyment of the water corridors principally to on-the-water activities. Current access to the water corridors is mainly at road and bridge crossings. A very few boat ramps, most privately owned, provide launching facilities (see Table 4 and Figure 7). A few day use areas provide viewing, and in some instances, swimming opportunities (see Tables 5 and 6 and Figure 6).

This limitation of facilities for access has both positive and negative aspects. On the positive side, limiting the number and size of facilities serves as a constraint on the number of visitors to the water corridors and decreases the pressure of human use on the natural resources. It also minimizes the amount of habitat fragmentation caused by development of such facilities.

FIGURE 7. BTNP BOAT RAMPS



On the negative side, current limitations on access may restrict use of the Preserve unnecessarily. It is possible that public use, and thus public recognition of the Preserve, could be increased beyond current levels without seriously impairing the quality of the natural resource if facilities were carefully developed.

Possible alternatives.

1) Increase river access by developing sites within the Preserve for canoe and boat launch or day use and/or cooperatively advertising private launch areas.

2) Control river access by restricting development of new sites for public access.

3) No change in current river access.

Recommended general guidelines. Provide a limited number of high-quality day use and canoe and boat launch facilities to provide public access to the water corridor units while minimizing disturbance to the natural area.

Recommended management actions.

1) Maintain or improve current facilities in condition for safe public use.

2) Review General Management Plan and current circumstances to determine if any additional facilities can be developed consistent with protection of the resource.

3.10 Littering, Dumping and Vandalism

Authority. Provision in the 1916 NPS organic act (16 USC 1) for public use and enjoyment can be construed as a mandate to maintain the Preserve in a natural condition, free of human trash and litter that detract aesthetically or functionally from public use and enjoyment of the resource.

NPS Management Policies (NPS 1988a) specifically addresses trash and litter management in a number of areas.

- Trash disposal and other operational activities are to be operated out of public view of cultural landscapes to the maximum extent feasible (5:6).

- Refuse may not be disposed of in backcountry areas; it is to be carried out. No refuse containers are to be provided by the NPS in backcountry areas. A limited amount of burning of refuse in backcountry areas is allowed if appropriate. (8:4)

- "Solid waste disposal on NPS lands is incompatible with the purpose for which the land was acquired or is being managed; therefore, every effort will be made to dispose of solid waste outside of NPS managed lands using approved regional landfills." (9:6)

- Utilitarian facilities such as solid waste disposal sites, if necessary within a park, are to be sited in remote locations low in resource value (9:16).

- NPS Management Policies (8:3) state that a "river management plan will be developed for each park having significant levels of river use, or the potential for such use." River management plans are intended to prevent unacceptable impacts on aquatic resources. Each plan is required to address the disposal of refuse and human waste.

36 CFR Sec. 1.5 gives the superintendent authority to locally issue limits on activity within parks to further a number of objectives (public safety, resource protection etc.). Sec. 1.5 provides that the superintendent may issue permits to impose a public use limit or establish conditions for activities that are restricted.

36 CFR 2.14(a) prohibits:

(1) disposing of refuse in other than refuse receptacles.
(2) Using government refuse receptacles or other refuse facilities for dumping household, commercial, or industrial refuse, brought as such from private or municipal property, except in accordance with conditions established by the superintendent.
(3) Depositing refuse in the plumbing fixtures or vaults of a toilet facility.
(6) Polluting or contaminating park area waters or water courses.
(7) Disposing of fish remains on land, or in waters within 200 feet of boat docks or designated swimming beaches, or within developed areas, except as otherwise designated.

Big Thicket National Preserve Establishment Act of 1974 [PL93-439] cites the "preservation, conservation, and protection of the natural, scenic, and recreational values of a significant portion of the Big Thicket area in the State of Texas" and "the enhancement and public enjoyment thereof," as the reason for the preserve's creation. Sec. 4(b) provides that "in the interest of maintaining ecological integrity of the preserve" construction of facilities (among other uses) will be limited and controlled.

The BTNP General Management Plan (NPS 1980) deals with refuse and sanitation facilities as part of its general discussion of public use areas -- interpretive or recreational subzones. The General Management Plan reiterates the limits on recreational development and communicates the philosophy that as many as possible support facilities will be located outside the preserve. There is an implied preference for private development and ownership of these facilities.

The BTNP Final Draft Statement for Management (NPS 1995a, pp. 9-10) cites the dumping of appliances, rubbish and other undesirable items by private landowners on both private and Preserve land in attempts to stablize banks as a detriment to aesthetic and scenic values and possibly a health and safety hazard to users of the waterways. The Statement for Management discusses flooding and its contribution of litter and nonpoint source pollution to the water corridors (p.10).

BTNP Standard Operating Procedure 94-7141-02 (Superintendent's Orders) (NPS 1994a) append backcountry use regulations to the backcountry camping permit. These regulations dictate that all trash and garbage must be packed out.

Background. The dumping of solid waste in rural areas has a long history--dating from county "dumps" that accepted household solid waste. One result of regulations designed to clean up county dumps in Texas was that many counties closed these facilities and householders turned to undesignated sites for disposal of their trash. The dumping of household refuse such as furniture, appliances, etc. on remote land persists in the Big Thicket area. This presents obvious problems of aesthetics, water quality degradation, and habitat destruction. Since trash accumulations attract additional trash, rapid removal of litter and trash helps keep a littering problem from worsening. One problem area has been identified in the BTNP -- an area near Cook's Lake Road near the park boundary where a culvert at Canal Road discharges from a residential area, trash floats down or is dumped. This affects the

Little Pine Island Bayou Corridor, with accumulated trash visible when vegetation is down (Personal communication with Ray Martinez, BTNP, NPS). Another particular concern within the Water Corridors is the disposal of waste from houseboats moored in the Preserve, as discussed above in section 3.6.

A related problem involves unauthorized dumping of building materials and other items to serve as rip-rap in an attempt to stabilize eroding banks. This is particularly prevalent along the Neches River in areas where there are homes along the bank (Callaway et al 1993). The impact of this practice on stream banks has been discussed in section 2.7.

Littering is associated with public activities in the Preserve, particularly swimming and picnicking. A particular issue with respect to the Water Corridors is litter left on sandbars and islands in the Neches River. This presents a special kind of problem because these areas are not developed and are operated under backcountry rules -- pack it in, pack it out. At current levels of visitor activity, volunteer clean-ups such as that of the state Clean Rivers Program sponsored locally by the Lower Neches Valley Authority can provide substantial assistance.

In some instances, efforts by the NPS to provide appropriate disposal facilities have been thwarted by persistent vandalism. For example, the designated primitive camping area near Timber Slough Road once included a self-contained toilet and trash receptacles. These were removed because of vandalism (Personal communication with R. Appling, BTNP, NPS, 12 April 1996).

Possible alternatives. With respect to littering, dumping and vandalism in the Water Corridor Units, the following alternatives are identified:

- Actively discourage littering and dumping by prosecuting violators.
- Actively encourage appropriate disposal by increasing the number of trash receptacles at day use sites and working with local jurisdictions to improve opportunities for appropriate disposal sites outside the Preserve.
- Maintain the status quo.

Recommended general guideline. The general policy of BTNP should be to eliminate littering, dumping and vandalism problems which threaten resources and diminish the quality of the outdoor experience through providing facilities in appropriate areas, and through education and enforcement of regulations.

Recommended management actions.

- Remediate existing trash dump sites by removing trash and restoring habitat whenever possible.
- Promote compliance with Preserve regulations by intensifying Ranger patrols at strategic places and times.
- Encourage volunteer trash cleanup programs in the water corridors such as those under the state Clean Rivers Program administered in the Big Thicket area by the Lower Neches Valley Authority.
- Include anti-litter information in visitor information brochures.
- Provide trash receptacles in appropriate areas.

3.11 Illegal Collection of Plants

In 1990, 99 species of native plants were known to have been illegally collected in 37 NPS units nationwide; in 1991, 88 species were taken from 41 NPS units. Although the presence of rare plants indicates that illegal collection could be a potential problem for the Preserve, this is not thought to be a serious problem in the Big Thick water corridors.

Impact to water corridor resources. Illegal collection of plants is a potential threat to species resources. No location in the BTNP has been identified as particularly vulnerable at present. Impact on the water corridors is thought to be minimal.

Recommended management actions.

This is a potential future problem, so the NPS can prepare for future management needs by 1) reviewing preventive measures taken at other similar NPS facilities or other preserves; and 2) monitoring plant resources and documenting evidence of any plant removal to signal a need for further management actions.

Considerations for NPS research. The NPS needs baseline inventory information on its plant resources.

4.0 Partnership Challenges

Partnership challenges deal with topics that involve the areawide setting of BTNP, its borders, neighbors and other institutions. All NPS facilities have neighbors with whom they must coexist; partly because of its configuration, BTNP has a large number of external contacts that are necessary to accomplish Preserve objectives.

4.1 Air Quality/Fire Management

Studies by Egan and Gordy (1981) and Gordy (1986) of lichen in the BTNP found no negative effects on populations or distributions directly attributable to air quality. An air quality monitoring station was established by the NPS in the Turkey Creek Unit in 1985 to monitor sulfur dioxide and ozone concentrations and related climatological data, and has found that significant ozone events occur during the summer months.

Controlled burning is reported to be an effective resource management tool that may be less available under currently developing air pollution control regulations. A large part of the Big Thicket is located within an Air Quality Maintenance Area subject to regulation under the federal Clean Air Act and its amendments. As a result, fire management techniques that traditionally have been available for forest and range resource management have been curtailed by restrictions on outdoor burning promulgated by the Texas Natural Resource Conservation Commission (TNRCC) and the U.S. Environmental Protection Agency. Current air pollution control regulations incorporate a concept of limiting total emissions within an airshed. Restricting outdoor burning could be used to offset additional emissions from other sources. Petrochemical industries and forest products industries in southeast Texas are major sources of emissions that influence air quality in the BTNP area.

The restrictions on outdoor burning may have considerable impact on forest and rangelands bordering the corridor waterways. Controlled burning is not considered to be extensive within the water corridors, thus the impact of changes in regulations affecting fire management is expected to be minimal within the corridors.

Impacts to water corridor resources. Restricted burning for management purposes may affect both habitat (air quality and forest snags) and species (birds, mammals and reptiles) resources. Fire management is not thought to be particularly important within the water corridors.

Recommended management actions. Several possible management actions could improve response to the issue of fire management under current air quality regulations:

- BTNP staff should participate in regional and state air quality planning efforts so that NPS views are known to regulators. Sound scientific data should be used to show that controlled burns are beneficial and that the impacts of controlled burns are acceptable.

- Cooperative efforts with the timbering and agricultural communities, such as seminars, to provide scientific information to the public and regulators should be pursued.

- Continued/expanded air quality monitoring would contribute to scientific data base available to resolve this issue. Given NPS budgetary constraints, funding from the Texas Natural Resource Conservation Commission or from the U.S. Environmental Protection Agency should be explored to assist in supporting this activity.

Considerations for NPS research plan. 1) Proponents of controlled burning question the accuracy of models used by regulators to characterize the impacts of those burns and suggest the models lead to needlessly restrictive policies. Additional information may be needed to improve the characterization capabilities of those models. 2)In other geographic areas, aerial deposition of toxics to waters is a growing concern. If water quality analyses at BTNP indicate the presence of toxics, the relation between air and water quality may become a topic of needed research.

4.2 Neighboring Land Uses

The BTNP, and particularly the water corridor units, have very long "edges" where privately-owned lands abut the Preserve. A number of land uses with potential negative effects exist or are expected in neighboring area:

- residential development (primary and secondary);
- timbering operation (commercial and private);
- industrial development (oil and gas; forest products);
- agriculture;
- publicly-owned facilities (e.g. water diversion, sewage treatment facilities).

Negative effects such as rip-rap, trash dumping, and sewage runoff from streambank development have been observed in field reconnaisance (Callaway et al 1993). Air and water pollution and the introduction of domestic pets and exotic species to the natural environment also are possible consequences of neighboring uses. As the southeast Texas area grows and becomes more urban, it is likely that challenges to avoid conflicts over external uses affecting the Preserve also will grow.

Residential development in the area of the BTNP would generally be called rural; however, there are several higher density subdivisions more typical of suburban areas (e.g. Wildwood). Particularly when these developments are situated along the banks of the rivers and streams of BTNP, conflicting values can come into play.

An extremely unusual meteorological event in October 1994 resulted in massive flooding in the area, including about 300 homes in the Bevil Oaks subdivision near the Pine Island/Little Pine Island Bayou Water Corridor. This flood was the second to occur within a few years and the last in a long sequence of less severe flooding. Many of the homes are in the 100-year flood plain. At least two U.S. Army Corps of Engineers' studies have been issued on the subject of how to alleviate flooding in the area, neither finding a benefit/cost ratio sufficient to warrant a project on the bayou (U.S. Army COE 1975, 1985). A number of Bevil Oaks homeowners believe that alterations to the bayou can prevent future floods from occurring. They are particularly interested in the removal of snags, which they contend jam flows and contribute to flooding (NPS 1994b). Because snags as important habitat for aquatic species (see discussion in sections 1.5 and 2.6) and stream modifications to increase flood carrying capacity might conflict with the NPS mandate to maintain the resource in pre-European settlement condition, NPS has been unable to meet their requests. A group of homeowners continues to discuss with NPS the possibility of altering the bayou as a way to alleviate flooding. Nevertheless, in November 1996, a few of the residents filed a class-action lawsuit against the NPS and other agencies who operate in the area requesting compensation for flood damages. The potential for this type of conflict increases as more tracts bordering the Preserve are subdivided for suburban development.

The timber industry is a major factor in the economy of East Texas. In terms of potential impact on Preserve resources, timbering is probably the most important land use in areas surrounding the BTNP. Of neighboring land uses, timbering accounts for about 95% of the land area. The effects of timber cultivation and harvesting have been examined in a number of southeastern U.S. settings (Shaw, 1995, in Hall and Bruce, 1996; Carraway and Norris, 1996). Among the potential impacts of this land use are: 1) land clearing, resulting in invasion of exotic species of vegetation, decreased food and cover for native animals, increased erosion, decreased shade for streams, and increased runoff pollution, including chemicals, sediment and debris; and 2) road and bridge construction and use, resulting in erosion at stream crossings, increased runoff pollution to streams, changes to drainage patterns and stream circulation, and increased fragmentation of habitat. Directly relevant to the water corridors, a study of forestry "best management practice" compliance and effectiveness in East Texas found that 1) erosion associated with stream crossings of logging roads was the most significant water quality problem encountered (Lord et al. 1992, cited in Shaw, 1995, in Hall and Bruce, 1996) and 2) of the 162 sample sites, 88% received ratings of fair or better on best management practices.

Additional issues related to timbering include unauthorized use of public land (encroachment onto BTNP lands), safety concerns relative to hunting clubs on neighboring timber industry land, and use by the public of private timber company roads to access BTNP facilities. All BTNP corridor units appear to have a substantial amount of neighboring timbering activities.

The industrial base of southeast Texas is mostly concentrated to the south and east of the

BTNP. There are industrial developments, mostly related to the timber industry, at sites that are near or border the Preserve. The paper mill located at Evadale has raised concerns about pollution of the Neches River (see discussion of water quality in sections 1.5 and 2.4). Continued development of privately-owned lands abutting the water corridors of the BTNP holds the potential to adversely affect BTNP resources. GIS capability is currently being developed by the NPS to monitor uses and ownership of lands neighboring the Preserve.

Impact to water corridor resources. Neighboring land uses have a significant local effect on habitat resources (water quality, streambank condition, aesthetics). Potential future development may result in more widespread impacts.

Recommended management actions. Because neighboring land uses are beyond the direct control of the NPS, cooperative efforts are needed.

- Education and partnership programs with area residents and organizations should continue.
- Law enforcement activities may need to be expanded.
- Special efforts to work cooperatively with timber companies in the area should be continued to avoid potential adverse impacts of this prevailing neighboring use.

Considerations for NPS research. To address impacts of neighboring land uses, information on changes in current land use and periodic documentation of any negative effects of those uses is needed. The baseline inventory of neighboring uses for the Neches River corridor should be maintained and expanded to other corridors.

4.3 Public Use of Private Lands/Trespassing

The BTNP has very long borders relative to the size of Preserve acreage. This configuration plus the backcountry nature of the Preserve makes it possible for visitors to BTNP to trespass on private lands neighboring the NPS lands. The water corridors, where in many cases lands abutting the waters are privately held, are particularly subject to this occurrence. This problem, which applies to all border areas of the Preserve, has the potential to create conflicts with BTNP neighbors.

At current levels of park use, the number of complaints of trespass are few. This problem may increase in severity as park use increases.

Impact on water corridor resources. There appears to be no current impact on water corridors.

Recommended management actions. Although this is not currently a serious problem within the water corridors, several preventive actions can be taken:

- Increase and improve boundary markings in a way that does not detract from the backcountry experience for Preserve visitors. Uniform boundary markings might be more recognizable and would lend identity to BTNP lands.
- Educate visitors about BTNP area and boundaries.
- Increase Ranger presence.

Considerations for NPS research. Monitor incident reports for any increasing occurrences of trespass incidents so that appropriate actions can be taken when needed.

4.4 Salt Water Barriers on the Neches River and Little Pine Island Bayou

"The Lower Neches Valley Authority has submitted an application for a Department of the Army permit to install temporary steel sheet piling salt water barriers, when needed throughout a three year period, in the Neches River at an area located between stream mile 33.5 and stream mile 35.0 and in Pine Island Bayou at or near stream mile 3.0, near Beaumont in Jefferson County, Texas" (U.S. Army COE, 1992). These sites are within the BTNP.

The saltwater barriers are needed to protect fresh water diversion points of the LNVA when water levels are low in Sam Rayburn Reservoir preventing releases of fresh water to combat upstream movement of saltwater. The temporary barriers are intended to be removed when lake elevations increase.

The need to prevent saltwater encroachment upstream is a recurring situation and "temporary" barriers have been used for many years (reportedly 36 times since 1944 in Pine Island Bayou, staying up for 3 days to 11 months) generating a considerable amount of negative public sentiment and subsequent debate. A long-term solution to the saltwater intrusion problem that has been proposed is a permanent saltwater barrier lower on the Neches River, below the confluence with Pine Island Bayou, and outside the boundaries of the BTNP. LNVA estimates that the permanent barrier would cost 20 times the average annual cost of using temporary barriers.

At public hearing in January 1993, LNVA summarized six issue areas that had been raised in public discussion:

1) Trapping fresh water fish downstream.
2) Steel cables anchored to trees on shore damaging trees.
3) Failed dams become eyesores when not removed.
4) Residences are being flooded by a backwater effect when dams are left in place.
5) Dams block boat traffic.
6) Warning signs and hazard lighting are needed.

Additionally, the NPS has raised the issue of National Environmental Policy Act (NEPA) procedures.

LNVA has negotiated an agreement with NPS. BTNP has agreed that LNVA will be permitted two structures with mitigating modifications, principally the installation of boat ramps. To assist in its planning, the COE has requested studies of boat use of the river to justify building boat ramps as a mitigation element. The permit to LNVA will be issued for a five-year period while the permanent saltwater barrier is being studied.

During a flood episode in 1996, the temporary structures were "blown out" by flood waters, but not according to design specifications. The dams were designed to fail in the center, so that stream banks would not be damaged. In fact, they held in the center and washed out on the ends so that a considerable amount of scour resulted in loss of land and vegetation on the banks of Little Pine Island Bayou. The LNVA is currently trying to find a way to remedy the design failure (Personal communication with T. Hebert, 1996).

Impact to water corridor resources. Saltwater barriers prevent saltwater intrusion to fresh water habitat, and as a result will have beneficial impacts on species resources (fish and invertebrates, possible reptiles and birds) as well as on water quality. The temporary saltwater barriers have negative impacts on shoreline vegetation and on the scenic and aesthetic quality of the Preserve. Without mitigating facilities, saltwater barriers also impede boating use of the water corridors, including use by law enforcement personnel.

Recommended management actions. The NPS should continue participating in the study and decision to build a permanent saltwater barrier lower on the Neches River to prevent saltwater intrusion without interfering with boater and other use of the water corridors.

Considerations for NPS research plan. The COE has requested a study of boating usage of the Lower Neches River and Pine Island Bayou. This information also would be valuable to the interpretive division of BTNP.

4.5 Stream Diversions/Water Rights: Trans-Texas Water Program

Studies are currently underway for a "Trans-Texas Water Program" that is considering among other options, the transfer of water between river basins. The state of Texas, represented by the Texas Water Development Board as lead agency, and several river authorities and cities looking for future surface water supplies, are exploring the possibility of meeting central and south Texas water needs by transporting water from basins with excess water (more water than the amount needed to meet in-basin needs projected for fifty years). Neither the Neches River nor the Trinity River is being considered as a source of additional water for transfer, but all proposed transfer routes from the Sabine River must cross both of these basins. Routes across the Neches will possibly pass through the BTNP.

A draft Phase I report for the Trans-Texas Water Program (TTWP) was issued in March 1994.

Sixteen possible routes are proposed for the transfer of water from Toledo Bend Reservoir on the Sabine River to the Houston area in the San Jacinto River basin. These routes will be more closely examined in later planning phases, which will take 5 - 10 years to complete. Of these routes, transfers from the Sabine to the Neches are contemplated in the very northern reach into Lake B. A. Steinhagen, and at the southern end of the Neches to make use of existing LNVA canals. The Neches to Trinity transfer options include taking water out of Steinhagen and moving it into the Trinity below Menard Creek (a BTNP water corridor unit) and, in the south, crossing the Lower Neches Corridor Unit at the LNVA canals and through Devers and other canals to the Trinity below Liberty.

Although avoiding impacts to BTNP has been one criterion for reviewing early routing alternatives, the possibility exists for disruptions to the water corridors from construction, fragmentation of habitat and/or alterations in water circulation or quantity. As part of the TTWP, a permanent saltwater barrier on the lower Neches River is being evaluated by the U.S. Army Corps of Engineers, Galveston District, to augment in-basin water availability by preventing salt water intrusion to the lower Neches River and Little Pine Island Bayou.

The Southeast Study Area Policy Management Committee of the TTWP has established a Technical Advisory Committee (TAC) of about 50 members to review and comment on work plans and products. Members include state and federal agencies, local and regional agencies, environmental and public interest groups, and private sector interests. The National Park Service is represented by BTNP Resource Management Division on the TAC.

Impact to water corridor resources. Specific impacts of possible interbasin water transfers are unknown at this time. The impacts of future full use of current water rights (currently permitted diversions) also are unknown.

Recommended management actions. NPS should continue to actively participate on the Technical Advisory Committee of the Trans-Texas Water Program to ensure that avoidance of impacts to BTNP continues as a principal criterion for evaluating alternatives.

Considerations for NPS research plan.

1) The NPS needs to know the potential impacts of any proposed stream crossings.

2) The NPS should cooperate with state agencies such as the Texas Parks and Wildlife Department and the Texas Natural Resource Conservation Commission to examine the implications of full use of currently permitted water rights on instream flows within the Preserve.

4.6 State and Federal Law Enforcement Inconsistencies

Inconsistencies between state and federal hunting, fishing and boating laws and regulations present difficulties to BTNP Rangers. Specific examples are: (1)The Texas Parks and Wildlife Department allows commercial fishing in the Neches River; BTNP allows only recreational and consumptive fishing; (2) state law allows loaded guns in boats; federal law prohibits loaded guns in boats. Inconsistencies create confusion and resentment of federal law among Preserve users. Rangers prefer the more restrictive federal laws about guns for personal safety reasons.

Impact to water corridor resources. There is a potential impact on submerged aquatic habitat resources and species resources (fish and invertebrates) from commercial fishing. No impact from commercial fishing acitivites has been documented at this time. Gun regulations affect the safety of law enforcement officers and users of the water corridors.

Recommended management actions. The NPS ability to respond unilaterally to this issue is limited. The following actions may aid in resolving this problem.

- Work with other federal facilities in Texas to negotiate changes in gun regulations with TPWD.

- Seek legislative remedies when conflicts in state and federal law impinge on BTNP ability to carry out its mission.

Considerations for NPS research. NPS should obtain information from TPWD on any commercial fishing operations in the water corridors.

4.7 Unauthorized Commercial Use of Preserve

BTNP has extensive borders and is configured in fifteen separate units, eight of which are water corridors. The rural nature of the area, together with its grazing and timbering land uses, also contributes to the potential for encroachment on Preserve property. Unauthorized use of BTNP property may result in degradation of the natural habitat and the conversion of public resources to private gain.

Impact to water corridor resources. Unauthorized use of Preserve resources has potential impacts to bottomland hardwood forest and may fragment habitat. Clearing or grazing would impact vegetation and may introduce exotic species. Encroachments from timbering and grazing activities may occur within the BTNP but have not been documented as a current problem for the water corridors.

Recommended management actions. If incidents of encroachment appear imminent based on neighboring land use activities, the NPS should increase and improve boundary markers and the presence of law enforcement personnel in the area.

Considerations for NPS Research. To address potential encroachment on BTNP area, the analysis of two types of information would be helpful:

1) information on type and location of neighboring land uses;
2) incident reports on unauthorized use of Preserve resources.

4.8 Economic Development and Tourism

The oil bust recession that hit Texas in the 1980's was particularly hard on the Beaumont-Port Arthur area. As a result, the South East Texas and Deep East Texas regions, within which BTNP is located, are actively seeking economic development. (South East Texas and Deep

East Texas are the names of designated multi-county state planning regions.) The maximization of recreational and tourism amenities such as the BTNP is an important component of this effort. The objective from the economic development point of view is to attract visitors in large numbers and to create jobs.

Government ownership of land and habitat preservation measures are sometimes viewed negatively as obstacles to economic development. Offsetting that view is a growing realization that substantial benefits can be gained from the tourism industry and that natural areas are important tourist attractions. Former BTNP Superintendent Ron Switzer was instrumental in forming the Southeast Texas Partnership for Tourism, Recreation and Environmental Education (SETPTREE), which has become an important regional group for both discussion and cooperative action. SETPTREE works closely with the Texas Department of Commerce Tourism Division and includes a membership of cities, counties, convention bureaus, chambers of commerce, private businesses, schools, parks and agency personnel.

Impact to water corridor resources. The potential impact of economic development activities is extremely variable. The extent of impact depends principally on the level and type of recreational and tourist use of water corridors promoted and the management techniques instituted to prevent negative impacts on natural resources. BTNP participation in economic development efforts benefits the Preserve generally through greater community support and awareness of its mission.

Recommended management actions.

1) Continue active support of and participation with SETPTREE.

2) Continue and expand use of press releases and speaking opportunities to provide community education aon economic importance of BTNP to region.

Considerations for NPS Research. Data on the regional, statewide and national economic importance of passive recreation as well as more traditional activities would help BTNP garner support for preservation efforts.

5.0 Summary and Conclusion

5.1 Summary of Actions for Managing Critical Resources of the Water Corridors

Table 5.1 summarizes the management actions recommended for each of the topics presented in preceding sections. These recommendations were developed in awareness of the funding and staffing constraints of the BTNP. Although these are not pie-in-the-sky recommendations, resource requirements for their implementation may exceed the current funding and staff resources available to managers of the Preserve.

5.2 Implications for Preserve Management

Several general observations have been drawn from the study and the recommendations. 1) The physical configuration of the BTNP makes it imperative that cooperative efforts with neighbors and communities in the southeast Texas area continue to be emphasized and fostered. Many important influences on the future of the Preserve simply are not within the control of the NPS, but they can be affected by NPS activity. 2) Since current levels of public use are relatively low, the Preserve has a wonderful opportunity to plan now for future public use within the constraints of the natural setting. 3) A timely investment in data collection along several fronts to better describe the ecological resources and visitation to the Preserve now would yield management dividends as future public use increases. 4) Data that are collected need to be analyzed regularly to glean management information. Quality controls for data collection need to be in place so that data can be used with confidence.

5.2.1 Information Needed to Protect Critical Resources

Administrative Records. Some of the information requirements for managing the resources of the BTNP are met through use of information regularly collected in day-to-day activities of the staff. These data may be collected for a single purpose, but can be used to meet several objectives. Slight modification of data collection practices or formats (as with visitor counts) or data bases (as with ranger incident reports) could improve accessibility of these data.

Table 5.1 Summary of Recommended Management Actions for Each Management Topic

Topic	Recommended Management Actions
2.1 Biodiversity	1) Continue to support the mission of maintaining ecological integrity of the Preserve; 2) Carry out and support an active research program to assess and manage for biodiversity; 3) Encourage neighbors to adopt management practices and land uses that help protect BTNP biodiversity.
2.2 Endangered Species	1) Continue to support protection of threatened and endangered species by cooperating with the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department and by implementing USFWS recovery plan criteria for threatened and endangered species known to occur in the Preserve. 2) Consider impacts of human uses of the Preserve on resident threatened and endangered species. 3) Look for opportunities to support species reintroduction or habitat enhancement programs (e.g. phlox reintroduction in Turkey Creek Unit).
2.3 Exotic Species	1) Support efforts of the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and the U.S. Natural Resources Conservation Service to prevent introduction of and to control the spread of exotic species.
2.4 Water Quality	1) The water quality monitoring program should be supported and coordinated with data collection efforts of other state and federal agencies. 2) Cooperative water quality sampling efforts with the Lower Neches Valley Authority (LNVA) should be pursued. 3) Water quality data should be collected under a quality assurance plan that is approved by the Texas Natural Resource Conservation Commission to allow NPS data to be used in state and federal enforcement actions.
2.5 Water Flow: Impoundments, Diversions, Releases	1) Continue to actively participate on the Technical Advisory Committee of the Trans-Texas Water Program to ensure that avoidance of impacts to BTNP remains a principal criterion for evaluating alternatives. NPS should make certain that location and design of any proposed river crossings have no negative impact on water corridor functions and values.

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
	2) Monitor the timing of drawdowns and flushes and work with the COE to influence the operation of the Steinhagen Dam (Dam B) so that any negative impacts on the water corridors are avoided.
2.6 Woody In-stream Substrate (Snags)	1) Monitor incident reports relative to boating safety to determine if there is a significant threat to human use of the water corridors. 2) Increase boater education about the presence of snags and their importance for habitat. 3) Consider identifying some areas as boating zones within which some snags will be removed for safety reasons. 4) Incorporate information on the importance of snags for aquatic habitat into general educational activities with area residents.
2.7 Stream Banks (Erosion and River Meander)	1) Continue legally defining water corridors, or at least the Neches River corridor units, in terms of stream-gradient-boundary for bank-to-bank inclusion in the Preserve; 2) Identify areas in which river meander has the potential to create boundary problems and seek management solutions with neighbors to any potential conflicts that are likely to arise; 3) Acquire additional lands bordering the Neches River corridor units, particularly in areas of active erosion, to bring more streambanks within Preserve management.
2.8 Floodplain Forest Habitat	1) Make certain that NPS facilities minimize fragmentation within the Preserve. 2) Participate in public planning activities, such as those for road construction, to prevent avoidable fragmentation and negative habitat impacts from neighboring uses. 3) Continue working with the oil and gas and pipeline companies in accordance with the Minerals Management Plan to minimize the impact on habitat of their activities within or near the Preserve. 4) Encourage neighbors to adopt management practices and land uses that minimize additional fragmentation of bottomland hardwood forests.

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
2.9 Aesthetic/Scenic Qualities	1) Work with neighbors in residences along river and stream banks to preserve the scenic quality of the corridors and discourage unsightly stream bank alterations. 2) Work with appropriate governmental units to prevent avoidable intrusions and minimize effects of unavoidable facilities such as roads and bridges. 3) Work with pipeline companies to minimize the visual impacts of pipeline crossings.
2.10 Archaeological and Cultural Resources	1) Consider improved public presentation (printed materials and displays) of archaeological and cultural information already in the possession of the NPS.
3.0 Public Use of the Preserve	1) Place more emphasis on collection of data on visitation (such as visitor counts) and add sites as appropriate to better describe visitation within the water corridors.
3.1 Hunting and Trapping	1) Curtail illegal taking of game through field patrols and contact with adjacent landowners, hunting clubs, and timber company hunting lease administrators. 2) Seek to eliminate problems caused by inconsistencies between Federal and State firearm laws. This can be accomplished in part by securing the assistance of TPWD in advising hunters about compliance with Federal laws while hunting on Federal preserves and refuges. 3) Promote safety of hunters in the Neches Bottom and Beaumont Units and visitors on waterways or neighboring lands by continuing to provide educational materials along with the hunter registration packet that promote safe handling of fire arms, good hunting etiquette, and a strong conservation ethic. a) Promote safety by providing maps that clearly delineate areas open to hunting to hunters and to other visitors, as well. b) To promote safety, ensure that adequate boundary and other orientation markings are established and maintained within the Neches Bottom Unit. 4) Establish a program for monitoring populations and harvest levels for game species within the preserve. 5) Consider redesigning the hunter and trapper harvest reports to include more information on size, weight, and condition

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
	of harvested game to contribute valuable ancillary information for resource protection and to provide a scientifically credible basis for determining the number of hunting and trapping permits to issue.
3.2 Fishing	1) Promote adherence to applicable fishing laws through casual field interviews initiated by Rangers on routine patrol. 2) Seek to eliminate problems caused by inconsistencies between Federal and State fishing laws. This can be accomplished in part by seeking the assistance of TPWD in advising fishermen about compliance with Federal laws while fishing in Federal preserves and refuges. A complete solution may involveswitching to a single set of fishing laws through legislative action at the Federal level. 3) Promote safety of fishers by continuing to provide educational materials and signage. 4) Acquire the fish population data necessary to assure that fish resources are adequately protected. This may be accomplished through transfer from other agencies, contract research, or staff monitoring of populations. Fisher harvest reports based on Ranger interviews, which include information on size, weight, and condition of harvested fish, as well as level of effort and mode of fishing., can provide some information for this purpose. 5) Prepare fishing action plan per the directive of the General Management Plan
3.3 Boating	1) Promote adherence to boat registration and boating safety laws through field interviews initiated by Rangers on a routine/casual basis, as well as routine patrols at strategic places and times. 2) Initiate monitoring programs to track visitor satisfaction and resource quality to provided a basis for identifying the recreational carrying capacity of the corridors. 3) Produce and distribute additional information brochures identifying opportunities for safe and resource-compatible recreational use. Consider distribution to targeted audiences such as those found at commercial outlets catering to boaters. 4) Acquire the data necessary to assure that biotic resources are not impaired by boating uses. This may be accomplished

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
	through transfer from other agencies, contract research, or staff monitoring of populations and bank conditions. 5) Address the use of boats for hunting, trapping and fishing activities in the hunting, trapping and fishing action plan to be prepared as directed by the General Management Plan. 6) Maintain NPS boat ramps in safe condition with suitable facilities for trash and human waste disposal.
3.4 Swimming and Picnicking	1) Promote adherence to Preserve visitor use and safety regulations through casual field interviews initiated by Rangers on routine patrol, as well as by regular patrols at strategic places and times. 2) Initiate monitoring programs to track visitor satisfaction and resource quality, so as to identify the recreational carrying capacity of the corridors. 3) Produce additional information brochures identifying opportunities for safe and resource-compatible recreational use.
3.5 Camping	1) Promote adherence to applicable backcountry camping regulations through casual field interviews initiated by Rangers on routine patrols. 2) Promote safety of campers by continuing to provide educational materials and signage, particularly at river access points. 3) Acquire the data necessary to assure that resources in visitor use areas are adequately protected. The necessary information can be acquired through (1) annual review of records and incident reports; (2) annual visual assessment of trash loads and camper impact on sandbar vegetation and bank conditions; and (3) water quality monitoring at sites near camping areas. 4) Adopt formal name for the two unnamed sandbars on which backcountry camping is prohibited to better communicate with the public. 5) Review and update the Backcountry Camping Management Plan periodically -- at least once every five years.

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
3.6 Houseboats in the BTNP	1) Work with TNRCC and LNVA on water quality sampling to determine impacts of houseboats. 2) Increase Ranger presence to document impacts of houseboats and discourage unlawful activities. 3) Work with State and Federal law enforcement agencies with regard to possible drug activities. 4) Rigorously enforce regulations to control impacts within the Preserve. 5) Issue no permits for houseboats not currently located within the Preserve and do not allow replacement of existing houseboats.
3.7 Mineral Extraction and Transport	1) Review BTNP Oil and Gas Management Plan for responsiveness to resource and administrative concerns. 2) Work with oil and gas and pipeline companies to develop operating plans for their activities in the BTNP that provide maximum biodiversity protection and minimum visual/aesthetic impact. 3) Work with other agencies and oil and gas industry to develop standards for pipelines that are appropriate to sensitive or hazardous locales such as waterways.
3.8 Trash and Waste Disposal	1) Post information promoting appropriate disposal of trash and human wastes. 2) Provide trash and human waste disposal facilities at all day use sites. 3) Continue to provide regular cleaning and maintenance of waste disposal facilities. 4) Contract for off-Preserve disposal of wastes whenever possible. 5) Work with other jurisdictions to develop alternative disposal sites.
3.9 River Access	1) Maintain or improve current facilities in condition for safe public use. 2) Review General Management Plan and current circumstances to determine if any additional facilities can be developed consistent with protection of the resource.
3.10 Littering, Dumping and Vandalism	1) Remediate existing trash dump sites by removing trash and restoring habitat whenever possible.

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
	2) Promote compliance with Preserve regulations by intensifying Ranger patrols at strategic places and times. 3) Encourage volunteer trash cleanup programs in the water corridors such as those under the state Clean Rivers Program administered in the Big Thicket area by the Lower Neches Valley Authority. 4) Include anti-litter information in visitor information brochures. 5) Provide trash receptacles in appropriate areas.
3.11 Illegal Collection of Plants	This is a potential future problem. Steps to prepare for future management can be taken now. 1) Review preventive measures taken at other similar NPS facilities or other preserves. 2) Monitor plant resources and document evidence of any plant removal to signal a need for further management actions.
4.1 Air Quality/ Fire Management	1) Participate in regional and state air quality planning efforts so that NPS views are known to regulators. 2) Continue to collect sound scientific data to show that controlled burns are beneficial and that the impacts of controlled burns are acceptable. 3) Pursue cooperative efforts with the timbering and agricultural communities, such as seminars, to provide scientific information to the public and regulators. 4) Explore cooperative funding arrangements with TNRCC or USEPA to continue or expand air quality monitoring to contribute to the scientific data base available to resolve issues of fire management and air quality.
4.2 Neighboring Land Uses	1) Because neighboring land uses are beyond the direct control of the NPS, continue cooperative efforts such as education and partnership programs with area residents and organizations. 2) Special efforts to work cooperatively with timber companies in the area should be continued to avoid potential adverse impacts of this prevailing neighboring use. 3) Law enforcement activities may need to be expanded.
4.3 Public Use of Private Lands/Trespassing	Although this is not currently known to be a serious problem within the water corridors, preventive actions can be taken.

Table 5.1 Summary of Recommended Management Actions for Each Management Topic (continued)

Topic	Recommended Management Actions
	1) Increase and improve boundary markings in a way that does not detract from the backcountry experience for Preserve visitors. 2) Consider uniform boundary markings that might be more recognizable and lend identity to BTNP lands. 3) Educate visitors about BTNP area and boundaries. 4) Increase Ranger presence.
4.4 Salt Water Barriers on the Neches River and Little Pine Island Bayou	1) Continue participating in the study and decision to build a permanent saltwater barrier lower on theNeches River to prevent saltwater intrusion without interfering with boater and other use of the water corridors.
4.5 Stream Diversions/Water Rights: Trans-Texas Water Program	1) Continue to actively participate on the Technical Advisory Committee of the Trans-Texas Water Program to ensure that avoidance of impacts to BTNP remains a principal criterion for evaluating alternatives.
4.6 State and Federal Law Enforcement Inconsistencies	1) Work with other federal facilities in Texas to negotiate changes in gun regulations with TPWD. 2) Seek legislative remedies when conflicts in state and federal law impinge on BTNP ability to carry out its mission.
4.7 Unauthorized Commercial Use of Preserve	1) If incidents of encroachment appear imminent based on neighboring land use activities, the NPS should increase and improve boundary markers and the presence of law enforcement personnel in the area.
4.8 Economic Development and Tourism	1) Continue active support of and participation with SETPTREE. 2) Continue and expand use of press releases and speaking opportunities to provide community education on the economic importance of BTNP to region.

Research Needs. These are to be drawn from research needs in topic areas.

5.2.2 Staff and Funding Resources Needed

5.2.3 Legislative or Administrative Action Needed

5.3 Conclusion

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See btnpbib2.wp6 for references

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